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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

Institute of British Foundrymen.

PRESIDENT: 1928-29:
S. H. Russell, Bath Lane, Leicester.

LIST OF SECRETARIES—

General Secretary: T. Makemson, Saint John Street Chambers, Deansgate, Manchester. London Office: 49, Wellington Street, London, W.C.2.

Birmingham: F. K. Neath, 24, St. Paul's Square, Birmingham.

Sheffield: T. R. Walker, 26, Castlewood Road, Fulwood, Sheffield.

Scottish: J. Bell, 60, St. Enoch Square, Glasgow.

Lancashire: H. Stead, 1st/36, Cheetham Hill Road, Stalybridge, Cheshire.

London: H. G. Sommerfield, Charterhouse Chambers, Charterhouse Square, London, E.C.1.

Newcastle-on-Tyne: F. Sanderson, 15, Handyside Arcade, Newcastle-on-Tyne.

East Midlands: H. Bunting, 82, Otter Street, Derby.

West Riding of Yorkshire Branch: S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.

Wales and Monmouth Branch: J. J. McClelland, M.I.Mech.E., Druslyn, Bishops Road, Whitechurch, Glam.

Middlesbrough: N. D. Ridsdale, 3, Wilson Street, Middlesbrough.

Foundry Trades Equipment and Supplies Association.

President: H. Winterton, Kelvinvale Mills, Maryhill, Glasgow.

Secretary: K. W. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.

Welsh Engineers' and Founders' Association.

Secretary: E. J. Griffiths, 20, Fisher Street, Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION.

The Registered Office and Laboratories of the B.C.I.R.A. are at :—
24, ST. PAUL'S SQUARE, BIRMINGHAM.
Telephone: Central 1885. Telegrams: CIRA.
The B.C.I.R.A. Scottish Laboratories are :—
Foundry Technical Institute, Meek's Road, Falkirk *(Telephone 332)*

Forthcoming Events.

JUNE 5-15.
International Foundry Trades Exhibition, Royal Agricultural Hall, London, N.

JUNE 10-14.
International Foundry Congress:—26th Annual Convention of the Institute of British Foundrymen.

Up with the Curtain!

The foundrymen of the world could not fail to be impressed by the dignity of the ceremony at the Guildhall and the warmth and cordiality of the reception accorded to them by the Right Honourable the Lord Mayor of London (Sir Kynaston Studd). It was a happy thought to ask him to present a souvenir medal to Professor Thomas Turner as a slight recognition of his pioneer work for the foundry industry. The replies of the foreign delegates from America, France, Germany, Italy, Spain, Belgium, Holland, Poland, Denmark, Czecho-Slovakia and Luxemburg were exceedingly enthusiastic in their appreciation of their reception, especially those who had been fortunate enough to participate in the pre-Convention tour.

The presidential address, eloquently delivered by Mr. Wesley Lambert, was of interest to every nation and to that cosmopolitan collection which goes to form the personnel of our complex industry. It showed a complete picture of its activities and will for many years serve as a work of reference to show the industry where there is still room for improvement just when we think we have achieved perfection. The award of the Oliver Stubbs Medal to the new President was made because its recipient so worthily fulfilled the conditions as laid down by the donors and not because it happened to be his year of office. These two honours which have been bestowed on Mr. Lambert have been well merited, and we offer our sincere congratulations. The foundry industry, through this international gathering, has been loud in its praises of both the Institute and its President. The organisation has been difficult because of this grafting-on of the Continental system of last-minute registration, but all will feel that the organising ability of Mr. H. G. Sommerfield and Mr. Tom Makemson will overcome the obstacles which apparently originated at the building of the Tower of Babel. It is still too early to distribute "bouquets" except for those who have by their initiative, enterprise and courtesy made the pre-Convention tour such an outstanding success. To the Lord Mayors, Lord Provosts, Mayors, Provosts, foundry owners, branch-presidents, secretaries and council and ordinary members we offer our sincere congratulations. A conversation with any participant makes one remember with mixed feelings the reception of one's first prize in the far-away schoolboy days. Debts of gratitude were created in Paris in 1923 and Detroit in 1920, and the present manifestation is an attempt to "straighten the books." Time alone will be the auditor, but whether we come out on the right or wrong side, we shall have had the satisfaction of knowing that we have done our best.

As Others See Us.

One of the most interesting features of such an extensive visit of our foreign confrères, as the one in progress at the present time, is the vivid fashion in which it brings home to us the ways in which the foundry trade in this country differs from the foundry trade abroad. It is possible from our knowledge of industrial conditions elsewhere to state with a fair degree of probable accuracy a number of points that will doubtless receive their share of comment. Our American visitors will certainly be struck by the smallness of size and daily output of British blast-furnaces, and the corresponding high quality of British pig-iron for remelting in the cupola. They will observe the prevalence of the jobbing foundry and the absence of any high degree of specialisation in production. They will notice the high quality of British castings with regard to soundness and finish, whether they are light castings or intended for engineering purposes, this being the result of the high standard of British craftsmanship. It is even possible that some of our visitors may think that we pay too much attention to this quality, and that our engineers demand a degree of finish that is quite unnecessarily high and in some respects against their better interests. Foundrymen from America will also observe the high quality of British moulding sands and refractories, and the corresponding absence of those methods of testing and control that are necessitated by artificially-bonded sands. They will also be struck by the scarcity of mechanised foundries for production purposes, whether for the transport of moulds, castings, or sand. There is, too, a comparative scarcity of technical control by a laboratory or metallurgical staff, though it will be noted that British research is of a high standard in spite of the slender resources upon which it is able to draw. There is only limited use of such modern equipment as sand-blasting. Centrifugal castings have been very highly developed, not merely for pipes but for high-quality piston pots and liners. The British cupola is run with striking economy in spite of some variety of design, and British metallurgical coke is of a very high quality. Finally, our American friends will note the high quality of the best British cast iron for engineering purposes, in spite of the fact that the use of proprietary methods is not extensive. In other words, British founders can and do produce cast iron of the very highest quality with nothing more than the ordinary raw materials that are available to anybody, together with the skilled labour and technical knowledge at their disposal. A cynical observer might even be tempted to remark that the British foundries excel in those directions in which God has been good to them. We make the most of our native advantages; and comments may not be lacking to the effect that were we also to endeavour to remedy our

native disadvantages we might well be in the forefront of the world. Our visitors from Germany and the Continent in general will see fewer differences than those from America, since their own conditions are not so very dissimilar to our own. They will, however, be inclined to marvel that the British foundry does as well as it does without technical control, and they will consider the provision for research grossly inadequate. The German founder rightly believes that his research expenditure is handsomely justified by the fact that metallurgists all over the world talk of cast iron in terms of German processes, German diagrams, and German theories.

How far the actual observations of our foreign friends will bear out these remarks will be a matter of no little interest.

Foundrymen's International Committee.

At a meeting of the above, held at the Hotel Cecil on Tuesday evening, Signor Comm. Ing. Carlo Vanzetti, C.B.E., was elected President for the ensuing year. France was asked to nominate a vice-president. It was announced that International (European) meetings would be held in Belgium in 1930, Italy in 1931, and the 4th International Foundrymen's Congress in Germany in 1932.

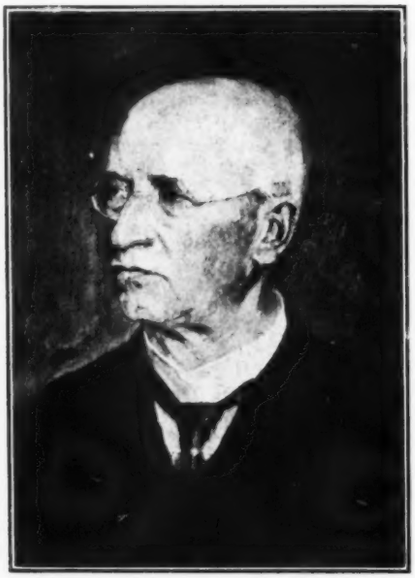
Mr. Tom Makemson was re-elected honorary secretary.

LEADING THE GERMAN DELEGATION.

Dr. Ing. Werner.

Dr. Ing. Geilenkirchen.

Herr Obering Langenohl.



Herr Dr. Justizrabt Walschmidt.

Random Shots.

Will I be accused of any very marked lack of originality if I refer to the Disillusion Honours just published? . . . The only item of any interest to the metallurgical world is the knighthood conferred upon Prof. H. C. H. Carpenter. He is, of course, Professor of Metallurgy at the Imperial College of Science and Technology, in South Kensington, and in addition to his brilliant work in the field of investigation, he has rendered signal service as a member of the Advisory Council of the Department of Scientific and Industrial Research, having been Chairman of the Industrial Grants Committee of that Council for the past four years. People who are interested in the history of iron will be interested to know, if they do not already know, that Professor Carpenter traces direct descent from Henry Cort, the inventor of the puddling process, and in fact bears his name. May we be permitted to offer our very cordial congratulations to him on his recent honour?

* * *

The only other name likely to prove of any interest to readers of this journal—apart from certain local distinctions, whose importance is not always recognised by "foreigners"—is that of Sir Arthur Balfour, who gave his name to the Balfour Committee on Industry and Trade, to which frequent references have been made in these pages. A baronetcy has been conferred on him.

* * *

If you were faced with the prospect of entertaining distinguished foreign visitors to England during the months of May and June, what would you give them to eat? Nine times out of ten, asparagus, strawberries and cream, lamb and green peas, and/or fresh salmon. Those are, after all, our national specialities; the cynic might observe that they are among the few things that cannot be ruined by our unimaginative cooking. These reflections are induced by the fact that our guests from abroad appear to be suffering from a surfeit of cold salmon, which, they say, has dogged their footsteps—or should it be their mastications—ever since they set foot on these shores! Let me appeal, then, to any who may still have the opportunity of entertaining them, for a little novelty on the menu, although I cannot help thinking that our friends might do worse than carry away an impression of perpetual cold salmon where the English dietary is concerned!

* * *

Those of us who have from time to time lunched, slept, or banqueted at the Engineers' Club were somewhat astonished the other day to see that imposing edifice figuring on the picture pages of our illustrated dailies, and were perhaps a little alarmed to read stirring accounts of "fire at a West End Club," and so forth. I gather, however, that the affair was not very serious, and that its effects are unlikely to interfere in any way with our nice little habits. . . . Still, the pictures of firemen and ladders were sufficiently exciting.

* * *

I have still a few rather good election tales left. There was the one about the very young candidate who was rudely asked:—"Does your mother know you're out?" and who replied promptly:—"Yes, and this time next week"—the polls being in the immediate future—"she'll know I'm in!"

Marksman.

Institute of British Foundrymen.

ANNUAL GENERAL MEETING.

The annual general meeting of the Institute of British Foundrymen was held at the Institution of Mechanical Engineers, London, on Monday, June 10, Mr. S. H. Russell—the retiring President—being in the chair during the early portion of the proceedings.

On the motion of the President, the minutes of the previous annual general meeting, held in Leicester on June 12, 1928, were taken as read and confirmed.

Council's Report.

The Report of the General Council for the year June, 1928, to June, 1929, was then formally presented, having previously been circulated, and, on the motion of the President, seconded by Mr. V. C. Faulkner, was adopted unanimously without discussion.

The General Council has pleasure in presenting their Report for the year 1928-29. The year has been one of steady progress, we are able to record an increase in the number of members, and an improvement in the financial position, whilst a step forward has been made in connection with the scheme for a national certificate in foundry practice, for the benefit of students attending either day or evening classes in these subjects.

It is within the knowledge of many members that from time to time the Institute has been seriously concerned by the need for a higher quality of recruit, and for better facilities for training them; but so far with but little result. It is hoped that better progress will now be made towards a solution of this very difficult problem. A sub-committee is considering the most desirable method of establishing an authoritative examining body, but much work has yet to be done before a definite scheme can be expounded.

The Board of Education Committee on "Training for the Engineering Industry" has applied to your Council for their views on "Foundry Apprenticeship and Training." The Literary, Awards and Education Committee has drafted and submitted a carefully-prepared reply to this request.

The duties allocated to the Literary, Awards and Education Committee become more numerous every year and it will soon be necessary to consider whether this Committee should not meet more frequently, so that greater progress can be made.

Much of the time of the Council has been spent in considering the arrangements for the International Congress to be held in London, and the entertainment of the Overseas Visitors during their visits to the various industrial centres of Great Britain.

Membership.

The number of members of all grades on April 30, 1929, was made up as follows:—

	Subscribing Firms.	Members.	Associate Members.	Associates.	Total.
Birmingham, Coventry, and West Midlands ..	2 (2)	88 (91)	95 (91)	19 (17)	204 (191)
East Midlands	4 (1)	40 (37)	83 (6)	2 (4)	129 (110)
Lancashire	9 (8)	115 (114)	197 (198)	9 (11)	330 (331)
London	4 (3)	139 (130)	87 (81)	11 (12)	241 (226)
Middlesbrough	5 (4)	26 (31)	34 (27)	6 (5)	71 (67)
Newcastle	10 (10)	59 (56)	49 (52)	89 (77)	207 (195)
Scottish	2 (1)	64 (68)	131 (143)	29 (30)	226 (242)
Sheffield	6 (7)	84 (84)	78 (84)	11 (11)	179 (186)
West Riding of Yorkshire ..	—	28 (29)	53 (56)	1 (2)	82 (87)
Wales and Monmouth ..	1 (0)	29 (25)	27 (22)	4 (4)	61 (51)
General	—	35 (34)	10 (8)	1 (1)	46 (43)
Total	43 (36)	707 (689)	846 (830)	182 (174)	1,776 (1,729)

The figures in brackets are for the Session 1927-28.

It is with great regret that the Council announce the death of 10 members. Eight subscribing firms, 55 members, 70 associate members, and 30 associates have been elected to membership during the year, making a total of 163. Owing to various causes 116 names have been erased, giving a net increase of 47.

It is realised that there are many persons in the foundry industry who are eligible for membership and to whom membership would be of considerable value, but who are not yet associated with the Institute. The Council would appeal to all members to get in touch with such gentlemen of their acquaintance, and point out to them the advantages of Membership.

Junior Sections.

The Institute's own educational work has been continued through the activities of the five Junior Sections, all of which have completed successful sessions.

MR. WESLEY LAMBERT, A.K.C.
The recently-elected President of the Institute of British Foundrymen.

Oliver Stubbs Medal.

The seventh award was made in June last to Mr. J. W. Donaldson, B.Sc., F.I.C., of Greenock, for Papers presented to the Institute embodying his researches into cast iron. Shortly after the award of the medal, the University of Edinburgh conferred upon Mr. Donaldson the degree of Doctor of Science, and the Council wish to congratulate him upon this distinction.

Buchanan Medal.

The work of the Junior Sections has been stimulated by the establishment of the Buchanan Medals. These have been established by anonymous donors, who have invested a sum of money in the name of the Institute, the interest from which is to be applied to the purchase of a silver medal each year for each Junior Section, the medal to be awarded as the result of an essay giving a résumé of the session's work of the Junior Section with which the candidate is associated. The donors have also presented to the Institute the dies from which the medals are struck. The Council wish to tender their sincere thanks for these valuable gifts.

Diplomas.

Five diplomas were awarded in June last for Papers given before the branches during the previous Session. The recipients and the respective branches before which the Papers were given are as follows:—

A. J. Beck	East Midlands Branch.
A. Hudson	Scottish Branch.
W. H. Poole	Newcastle Branch.
N. D. Ridsdale... ...	Middlesbrough Branch.
P. A. Russell, B.Sc. ...	East Midlands Branch.

General Council.

Four General Council meetings and a number of sub-committee meetings have been held at Leicester, Weston-super-Mare, Birmingham and York; several sub-committee meetings have also been held in London and Manchester. At the General Council meetings there has been an average attendance of 33.

The following members of the General Council retire at the General Meeting on June 10. All retiring members offer themselves for re-election:—Messrs. W. T. Evans, A. Firth, J. Haigh, A. Harley and H. Winterton.

Test Bar Committee.

This Committee has met four times during the year, and has devoted considerable attention to practical investigation of the Frémont Shear Test. It was felt desirable to examine this test fully, as it has repeatedly been put forward in various International exchange Papers. The report is not yet completed, but two members of the Committee have published Papers pointing out certain difficulties which have been encountered in connection with this test. It is expected that the results published in these Papers will be considered during the coming Congress, and your Committee will then be in a position to carry out further investigations if necessary.

The convener of the Test Bar Committee, Mr. John Shaw, desires to place on record his appreciation of the help the members have given during the twelve years the Committee has been in existence. It is not generally recognised that hundreds of tests have been made, the cost of which under ordinary conditions would considerably exceed £1,000, the work, however, has been done without any cost whatever to the Institute, and the thanks of the members of the Institute are due to the members of the Test Bar Committee, who have made considerable sacrifices of time and money.

Annual Conference, 1928.

The Twenty-fifth Annual Conference was held at the Association Hall, Leicester, in June, 1928, and was very well attended. Mr. S. H. Russell was installed as President. The General Council wish to express their appreciation of the arrangements made by the Convention Committee, and particularly the chairman, Mr. Sidney A. Gimson (Past-President of the Institute), Mr. H. H. Moore (treasurer), Mr. H. Pemberton (Branch-President), and Mr. H. Bunting (secretary). The Council also wish to tender their thanks to the Lord Mayor of Leicester and to the many firms in the East Midlands area who entertained the members and ladies at their works, and to the subscribers to the Conference Fund.

International Congress.

The next Annual Conference is being held in London from June 10 to 14, inclusive. This Conference should be a notable one, as it forms the third of the series of Triennial International Foundrymen's Congresses, the first of which was held in Paris in 1923, and the second in Detroit in 1926. A large number of members and ladies of American and Continental foundrymen's associations are expected to be present, and, previous to the Congress, a party of the overseas delegates and ladies will tour Great Britain under the auspices of the various branches of the Institute.

International Relations.

Your General Council still maintains very close relations with overseas foundry technical associations, as evidenced by the holding of the International Conference under the auspices of the Institute in June. Included in the Papers to be read at this Conference there will be several Papers officially presented by various overseas associations.

Exchange Papers have been presented on behalf of the Institute by Dr. J. W. Donaldson at the French Foundry Conference, October, 1928, and by Mr. F. Hudson at the Conference of the American Foundrymen's Association, April, 1929. Mr. T. Henry Turner, M.Sc., is preparing a Paper, on behalf of the Institute, for presentation to the next French Foundry Conference to be held in October next. The Institute is represented on the International Committee of Foundry Technical Associations by Mr. V. C. Faulkner, and your general secretary continues to act as secretary of this Committee.

British Cast Iron Research Association.

The work of this Association has progressed on normal lines during the year. There is a steady but slow increase in membership and income. In June, 1929, under present arrangements with the Department of Scientific and Industrial Research, the Government grant hitherto received by the Association will fall to one-half, and under these circumstances the Association will only be able to continue on its present scale with the aid of more subscribing members.

The work done during the year has carried a number of developments a stage further from the purely metallurgical side, and several advances of very great interest have been made. One of these, dealing with the influence of manganese in relation to sulphur, will be presented to the London Congress in the form of a Paper by Dr. A. L. Norbury. Other developments refer to relationships between structure and composition, alloy cast irons, heat-resisting irons and malleable iron. Work on moulding sands has reached a point at which particulars have been placed before members, of simple foundry-control tests, which will enable sand conditions to be related to troubles experienced, and to enable a minimum of new sand to be employed consistent with safety. Developments of an important character with respect to the cupola have also been made by Mr. J. E. Fletcher, and thus the Association is in a position to advise members in respect of moulding practice, melting practice and mixtures in directions which should result in economies much greater than the annual subscription.

Accounts.

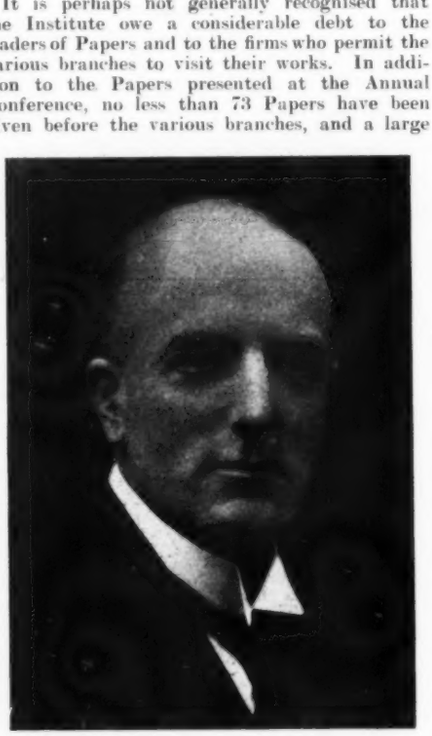
The statement of accounts and balance sheet for the year ended December 31, 1928, are set out below.

It will be noted that the income has exceeded the expenditure by £300 5s. 6d. Your Council realised some time ago that rigid economy in working, together with increased membership and regular collection of subscriptions, was necessary to put the Institute's funds on a sound basis and they are happy to announce that the Institute's finances are in a more satisfactory condition than they have been for some time. In this connection they wish to acknowledge the co-operation they have received from the branches, and particularly the Branch-Secretaries. It is felt that if this policy is continued, sufficient funds will be accumulated to extend further the Institute's work and usefulness.

Mr. F. P. Wilson, J.P.
The recently-elected Senior Vice-President of the Institute of British Foundrymen.

Branch Activities.

It is perhaps not generally recognised that the Institute owe a considerable debt to the readers of Papers and to the firms who permit the various branches to visit their works. In addition to the Papers presented at the Annual Conference, no less than 73 Papers have been given before the various branches, and a large



Mr. A. Harley.
The recently-elected Junior Vice-President of the Institute of British Foundrymen.

number of works visits have also been arranged. In addition, each Junior Section has carried out a complete programme of Papers and visits.

To the authors of all these Papers and to the managements of the various works the General Council wishes to express its very sincere thanks.

S. H. Russell, *President.*
T. Makemson, *General Secretary.*

BALANCE SHEET, DECEMBER 31, 1928.

Liabilities.

	£ s. d.	£ s. d.
Subscriptions paid in advance		164 17 0
Sundry Creditors		389 2 0
The Oliver Stubbs Medal Fund :—		
Balance from last Account	203 10 8	
Interest to date	8 4 4	
	211 15 0	
Less Cost of Medal ..	9 10 0	
		202 5 0
The Buchanan Medal Fund		97 16 3
Turner Testimonial Fund		
Balance from last Account	72 14 4	
Less Cheque Professor Turner	70 0 0	
	2 14 4	
Sundry Receipts ..	11 9 0	
		14 3 4
Surplus at December 31, 1927	950 16 9	
Add : Excess of Income over Expenditure for the year ended December 31, 1928	300 5 6	
		1,251 2 3
		£2,119 5 10

Assets.

	£ s. d.	£ s. d.
Cash in hands of Secretaries :—		
Lancashire	21 8 9	
Birmingham	37 7 1	
Sheffield	147 7 9	
London	137 18 5	
East Midlands	22 7 2	
West Riding of Yorkshire	24 3 10	
Middlesbrough	11 18 11	
		402 11 11
Lloyds Bank Ltd. :—		
General Account ..	476 13 2	
Deposit Account ..	400 0 0	
		876 13 2
The Oliver Stubbs Medal Fund :—		
£342 5s. 7d. Local Loan £3 per cent. Stock at Cost	200 0 0	
Balance in hand, Lloyds Bank Ltd.	2 5 0	
		202 5 0
The Buchanan Medal Fund :—		
£125–£3 10s. Conversion Stock at £78		97 16 3
Turner Testimonial Fund :—		
Cash at Bank	12 16 5	
Cash in hand	1 6 11	
		14 3 4
Investments Account		
£450 5 per cent. War Loan at Cost		430 9 10
Furniture, Fittings and Fixtures :—		
Per Last Account ..	105 18	
Less : Depreciation 10 per cent.	10 11 8	
		95 6 4
		£2,119 5 10

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED DECEMBER 31, 1928.

Expenditure.

	£ s. d.	£ s. d.
Postages		75 16 1
Printing and Stationery, including printing of Proceedings		525 3 0
Council, Finance and Annual Meeting Expenses ..		62 5 7
Medals for Past-Presidents		2 6 6
Branch Expenses :—		
Lancashire	111 14 9	
Birmingham	56 2 7	
Scottish	89 13 8	
Sheffield	54 11 10	
London	35 3 3	
East Midlands	36 13 7	
Newcastle	84 18 0	
West Riding of Yorkshire	33 3 0	
Wales and Monmouth	32 10 1	
Middlesbrough	25 6 6	
		559 17 3
Audit Fee and Accountancy Charges ..		12 12 0
Incidental Expenses		73 14 6
Salaries—Secretary and Clerk		468 0 1
Rent and Rates of Office less Received ..		77 10 4

	£	s.	d.
Income Tax	6	16	0
Subscription to International Committee of Foundry Technical Associations ..	5	0	0
John Surtees Memorial Examinations Grants to Branches	22	18	0
Depreciation of Furniture	10	11	8
	1,902	11	0
Excess Income over Expenditure ..	300	5	6
	£2,202	16	6

INCOME.

	£	s.	d.
Subscriptions Received	2,132	9	10
Sale of Proceedings, etc.	9	1	0
Interest on War Loan and Cash on Deposit	39	7	8
John Surtees Medal Fund, Surplus ..	21	18	0
	£2,202	16	6

We have prepared and audited the above Balance Sheet with the Books and Vouchers of the Institute and certify same to be in accordance therewith.

J. & A. W. SULLY & COMPANY,
Chartered Accountants,
Auditors.

19 & 21, Queen Victoria Street,
London, E.C.4.
May 13, 1929.

Accounts.

The PRESIDENT, in presenting the accounts for the past year, expressed satisfaction that there was a balance of over £300 on the right side, the largest amount that had ever been shown as a credit balance in one year. The assets of the Institute, he pointed out, were represented by £450 in 5 per cent. War Loan, which had cost £430 9s. 10d.

The motion by the President for the adoption of the accounts was seconded.

MR. SUTCLIFFE asked why a London firm of accountants was employed to audit the accounts when the general offices of the Institute were in Manchester. He also pointed out that two of the Branches were holding sums of £175 and £137 respectively, and asked what it was proposed to do with regard to this.

The PRESIDENT, replying to the first point, said he did not think there could be any serious objection to the employment of a London firm of auditors. The registered offices of the Institute were in London, although the general offices were in Manchester, and the firm in question were almost of worldwide repute. With regard to the amounts held by two Branches, as pointed out, the General Council had had that fact in mind, but it was not felt that the Council was in a position to ask for that money to be refunded. They were exerting such influence as they could to induce the Branches in question to use some of that money instead of asking for new grants, and the point raised by Mr. Sutcliffe would be borne in mind. He was informed by the secretary that the sums held by the Branches mentioned represented subscriptions.

MR. COOK pointed out that the auditors had to be re-elected at the annual meeting, and therefore it was open to anybody to make a new nomination if they desired to do so.

The accounts were then unanimously adopted.

Alterations to By-Laws.

The PRESIDENT then dealt with some alterations to the by-laws.

The first resolution, he said, dealt with the election of the Council, the object being to have a postal ballot instead of electing the Council by voting at the annual general meeting, at which it was not always possible for some of those who took a keen interest in the affairs of the Institute to attend. As Mr. Cook had been responsible for the first resolution, he asked him to speak to it.

MR. F. J. COOK said it had occurred to him that to elect the Council by postal ballot instead of by attendance of members at the annual meeting would be more satisfactory, because it gave everybody an opportunity to vote for their rulers in the Institute, which in this democratic country was what we desired.

The motion that the election of the Council in future should be by postal ballot was seconded and carried unanimously, it being explained by the President that the election on the present occasion would be by voting at the meeting.

The PRESIDENT said the second resolution, dealing with the by-laws, related to the application form for membership, and as it was necessary to get the permission of the Privy Council to the previous alteration, it was felt desirable to ask, at the same time, for any other alteration, thus reducing expense and trouble. The proposal was that, in the form for application for membership, the declaration that those proposing the applicant believed, to the best of their knowledge, that he was not of enemy or alien birth or interests, should be deleted. The Institute no longer wished to debar membership on the ground of nationality, but the other proposal in the resolution as sent out, to delete the words "nationality by birth or parentage," was due to a misunderstanding, because, although there was no desire to debar membership on account of nationality, it was desirable that the General Council should know the nationality of its members. Therefore, the deletion of these words would not form part of the resolution as put to the meeting.

MR. T. MAKEMSON.
The General Secretary of the Institute of British Foundrymen.

MR. F. SANDERSON (Newcastle) said the resolution came from his district, and, as the President had pointed out, the second part of the resolution was due to a misunderstanding. He therefore moved the first part relating to the declaration as to the knowledge of those putting forward an applicant regarding his enemy or alien birth or interests.

The motion was seconded and carried unanimously.

The Oliver Stubbs Medal.

The PRESIDENT then announced that the Oliver Stubbs Medal had been awarded to Mr. Wesley Lambert, and in connection with the award he read the following recommendation from the London Branch:—

"The General Council will require no detailed list of the innumerable services over a long period of years that Mr. Wesley Lambert has rendered to the Institute. There is scarcely a Branch before whom he has not lectured, and I should think there is scarcely a Committee on which he has not served. Particularly as Convener of the Literary Committee has he contributed materially to the solid foundations of the Institute. In addition to having been the London Branch-President, he is now President-designate of the Institute, and the London Branch Council feel there could be no more fitting or qualified recipient this year of the award, and they sincerely hope the General Council will accept and endorse the recommendation of the London Branch."

Continuing, the President said the General Council, in making the award, had done so quite apart from any consideration of the fact that Mr. Wesley Lambert was being nominated as President of the Institute. It felt that it was quite time the non-ferrous section of the industry should be recognised, and they felt there was no worthier exponent of that branch than Mr. Wesley Lambert. The award had been made entirely on its merits. The actual presentation of the medal would be made the following morning.

MR. WESLEY LAMBERT, in expressing his appreciation of the award, said that such little work as he had been able to do for the Institute of British Foundrymen was because he considered it one of the foremost, if not the foremost, of technical institutions in Great Britain. Another reason why he appreciated the award was that it was largely due to Mr. Oliver Stubbs that he had been induced to take a keen interest in the Institute, and he would value the award if only for the reason that it perpetuated the name of Mr. Oliver Stubbs.

On the motion of the PRESIDENT it was decided to send a message from the Institute to Mr. Oliver Stubbs expressing sympathy with him in his serious illness and wishing him a speedy recovery.

Diplomas.

The award of Diplomas was announced as follows:—

Mr. D. H. Wood, for a Paper read before the Birmingham Branch entitled "History of Ironfounding in the Midlands"; Mr. Ben Hird, for a Paper read before the East Midlands Branch and also the Newcastle Branch entitled "Coal Dust: Its Use and Abuse in the Foundry"; Mr. E. Longden, for a Paper read before the Newcastle, Scottish and Middlesbrough Branches entitled "Some Interesting Moulding Jobs"; and Mr. W. McCulloch, for a Paper read before the Scottish Branch entitled "Monel Metal and other special Non-Ferrous Castings."

Buchanan Medals.

The announcement was then made of the following awards of Buchanan Silver Medals to members of Junior Branches for résumés of the Papers read before the Branches during the year:—Mr. Norman Blyth (Scottish Junior Section); Mr. John Hird (Birmingham Junior Section); and Mr. J. Eric Garside (Lancashire Junior Section).

The New President.

The PRESIDENT said his next and last duty as President was to propose the election of Mr. Wesley Lambert as his successor. They had already awarded Mr. Lambert the Oliver Stubbs Medal, and it was difficult to find words to add to what had been said. A better choice could not have been made, because those who had worked with him for many years realised how great were his abilities and how great was his interest in the work of the Institute. He was one of the foremost men on the non-ferrous side of the industry, a side that was apt at times to be a little neglected. Mr. Wesley Lambert has had a very wide experience, wider and more varied than fell to the lot of many of them, and he was always prepared to place not only his knowledge but also the whole of his information at the disposal of any member of the Institute. He had placed himself at the disposal of all the Branches with regard to giving Papers, and an

Convener of the Literary, Awards and Education Committee he had done remarkable work. When, last year, owing to the duties concerned with the International Conference, he found it necessary to resign, the Committee missed his help and advice very much indeed. He therefore moved with the greatest pleasure that Mr. Wesley Lambert be elected President of the Institute.

Mr. F. J. Cook seconded the proposal, which was carried with acclamation.

Mr. Wesley Lambert then took the Presidential Chair, the retiring President promising him every assistance not only personally but by all the members of the Council and of the Institute.

The new President, in expressing his appreciation of the honour that had been conferred upon him, said he would not have gone forward as President if he had not been satisfied that he would have the support of everybody, as had so kindly been promised by Mr. Russell. Having worked for many years on the Council he could assure the general body of the members of the Institute that the men they elected to serve them on the General Council were very keen indeed, and knowing the keen feeling that existed he was looking forward to a very successful year of office. In connection with the International Conference, he said that the overseas delegates who were here were a fine body of men and gentlemen in every respect, and he appealed to the members of the Institute to make their visit here as pleasant and enjoyable as possible.

Continuing, the President proposed a hearty vote of thanks to the retiring President, Mr. S. H. Russell. The manner in which he had carried on the work of the Institute, he said, was seen in the fact that there had not been a single complaint of the way in which the business had been conducted during the past year. That was very great testimony to the tact and ability of Mr. Russell.

Mr. V. C. Faulkner said it was peculiarly fitting that he should be asked to second the vote of thanks because perhaps he had better opportunities than most members of the Institute in knowing the work of the President. He had been with him at most of the Branches and knew the amount of work and travelling, often on Sundays, in going round to the various Branches. He also felt that the vote of thanks should include Mrs. Russell and Mr. Russell's brothers, who had had a great deal of extra work thrown upon them during Mr. Russell's term of office.

The vote of thanks was carried with enthusiasm.

The President then handed Mr. Russell the Past-President's Badge.

Mr. Russell, acknowledging the vote of thanks, said he had really enjoyed being President, although it had involved a certain amount of hard though interesting work. There were two things he wished to refer to. He had hoped that by the end of his year of office he would have seen the question of the national certificate for the apprentices a great deal more advanced than was actually the case. Everything possible had been done, but progress was very slow, and there was a long way to go yet before their desires in that direction could be achieved. The other matter was one he had alluded to in his Presidential Address, viz., that the status of the Institute would be enhanced by some form of examination for membership. That was his personal view, but he was sorry to say he had come to the conclusion that it was premature to ask for that at present. Nevertheless he hoped to see it in the near future. He did not think it necessary to ask for a written examination; some other form of examination could be found, and he hoped that this would be possible in the course of the next few years. Any little success he might have had in business was undoubtedly due to the fact that he had always been keen on attending the Branch and annual meetings of the Institute, and he felt that in return it was only right that he should push forward the work of the Institute in every possible way.

Senior Vice-President.

The President then moved the election of Mr. F. P. Wilson as senior Vice-President for the coming year.

Mr. J. T. Goodwin, in seconding, said he had known Mr. Wilson for many years, and as long as 24 years ago, when the Conference was held in Middlesbrough, Mr. Wilson took a great part in organising the arrangements. Mr. Wilson was one of the progressive foundrymen in Middlesbrough, and had played a great part in the development of the Middlesbrough Branch.

The motion was carried unanimously.

Mr. Wilson, acknowledging his election, said that, although he had not long been a member of the Council, he had been a member of the Institute for many years in a remote corner of the country, which, perhaps, was not much more than a name to many people. The Middlesbrough Branch, however, felt greatly honoured that he should have been selected for nomination as senior Vice-President, and when the Branch knew he had actually been elected it would be still more pleased. Looking at the past-Presidents, he realised what a brilliant body of men they had been, whereas he himself could only claim to be of the commonplace type and a representative of the commonplace people. At the same time he felt pleased that the commonplace people should be represented in this manner on the Council. He felt that he represented the rank and file of the Institute, among whom he counted many of his best friends.

Mr. H. G. Sommerfield.
The Convention Honorary Secretary.

Junior Vice-President.

Mr. S. H. Russell then proposed the election, as junior Vice-President, of Mr. A. Harley, whom he described as one of the most prominent foundrymen in the Birmingham district and one who had done a tremendous amount of work on different Committees of the Institute.

Mr. Cameron, who seconded the proposal, referred to Mr. Harley's association with the Daimler Company, and assured him that he would find the work involved in the office of junior Vice-President most enjoyable.

The proposal was carried unanimously.

Mr. Harley, in expressing his thanks for his election, said he also regarded himself as one of the commonplace people, like Mr. Wilson. He was a very commonplace man coming from a very commonplace family, most of whom had toiled and sweated in foundries. His father did so for 50 years, and there were two men whom he wished were present that evening. One was his father and the other was Mr. Robert Buchanan. When he joined the Birmingham Branch about 20 years ago Mr. Buchanan was kindness itself in receiving him, and before that, when he did not know Mr. Buchanan, one of his Papers had been a God-send to him when he was struggling with some of the problems of cupolas. He afterwards took the opportunity of telling Mr. Buchanan what a help that Paper had been to him, and it certainly was an example of the advantage to others that came from Papers given by men who had special knowledge on a particular subject. He himself was in Shropshire at the time he spoke of, out of contact with foundrymen generally, and he had a very vivid remembrance of the benefit he received from that Paper by Mr. Buchanan. He had actually intended to retire from the Council, but when it came to the point he could not bring himself to sever the friendships he had made. The members of the Council were a very fine body of men, not only from the foundry point of view but personally, and he could only hope that he would be able to carry out the duties of junior vice-president in a proper manner.

Members of Council.

A ballot was then taken for the election of five members of Council, for which there were six candidates, the result being announced at the opening of the International Conference the following day. They were Mr. J. Haigh, Mr. W. T. Evans, Mr. H. Winterton, Mr. D. H. Wood, and Mr. A. Firth.

Honorary Officers.

Mr. F. W. Finch was unanimously re-elected hon. treasurer.

Messrs. F. J. Cook, R. O. Patterson and O. Stubbs were unanimously re-elected trustees for the Institute.

Auditors.

Messrs. J. and A. W. Sully & Company, 19-21, Queen Victoria Street, London, were unanimously re-elected auditors.

Vote of Thanks to General Secretary.

On the motion of Mr. E. Longden, seconded by Mr. Wood, a cordial vote of thanks was passed to the General Secretary, Mr. T. Makemson, for his work during the past year.

Mr. Makemson acknowledged the vote of thanks, and remarked that his work was very much facilitated by the great assistance he received from everybody. He liked the work very much, and was able to extract from it not only a great deal of interest, but at times some amusement, often from unexpected quarters. He recognised that everybody was reasonably sympathetic; they appreciated everything he did and any mistakes that he made—and he feared he did make mistakes at times—were regarded very leniently.

Subscriber Firms.

Mr. Sutcliffe raised the question of the position of subscriber firms, and said he would be able to induce several firms to join but for the fact that they had no vote or voice in the control of the Institute. There were instances in which prominent members of subscriber firms would be valuable additions to the Council, but through the rules concerning such firms they were ineligible.

A Delegate suggested that it was not in order to bring this matter forward now, but that a communication should be sent to the General Secretary so that he might bring it before the Council.

The President expressed the view that Mr. Sutcliffe was in order in raising the point he

(*Continued on page* 458.)

American Foundry Practice.

By D. M. Avey (Editor of "The Foundry").

American foundry practice within the past fifteen or twenty years has shown tremendous advances. These have been marked by the attainment of higher quality at decreased cost and with greater economy in man-power. Mechanisation, the application of machines to do the work of men, has brought about this trend. A large measure of credit accrues to the automotive industry, which has demonstrated to American manufacturers the wisdom of methods which are variously termed production, mass-production, or repetitive work. Another lesson learned from the automobile builders is the wisdom of paying high wages or piece-work rates as a stimulus to greater output. The spirit of workmen has been inspired by their ability to measure greater effort by enhanced returns.

Inasmuch as the automotive factories pointed the way, the foundries making automobile castings either on a jobbing basis or directly for their owner-plants have led the procession in the adoption, use and improvement of mechanical aids to foundry production. Agricultural and stove foundries were the first to use mounted patterns, hinged flasks, and other aids to repetition moulding, but the first foundry firms in America to accept the faith in complete mechanisation were automotive shops. They found that moulds could be safely trusted to moving conveyors, that sand could be mixed uniformly and delivered quickly by mechanical means, and in many other operations machines could serve. Other classes of foundries, namely, the radiator, railway speciality, electrical machinery, implement, and sundry others, quickly found that where large production was a factor, mechanisation led to increased output at lower price.

Obviously, the first step in the substitution of mechanical for manual operations was in moulding. It seems almost unbelievable that only a little more than a quarter of a century ago extended discussion at foundrymen's meetings raised the question of whether a mould could be made accurately on a moulding machine. The acceptance of moulding machines really paved the way for present-day methods. The ingenuity of moulding-machine manufacturers proved that castings manufacture is not entirely an art, and, as artisans, foundrymen can reproduce the same object repeatedly in metal without change or defect.

Substitution of steam, pneumatic or electrical motive power to cranes represented another marked step in advance, but still foundrymen mistrusted any form of moving conveyor. They felt that the delicate nature of moulds, particularly those made from green sand, made it absolutely impossible to move these moulds about after they had been completed, cored and closed. When the fallacy of this view was proved by those who ventured to experiment, progress was more rapid. A large electrical foundry in Pennsylvania probably was the first to conquer the prejudice against green-sand mould transfer.

Mechanical sand-handling met with many reverses. The abrasive nature of the material handled, the prevalence of dust, ever a menace to moving parts, however tightly enclosed, constituted one stumbling-block. Another detriment was the feeling amongst foundrymen that if hot sand was taken from the shake-out and returned too soon to the moulding station, difficulties would result. Furthermore, physical difficulties in removing burned sand, core rods, gaggers and tramp iron presented problems that the equipment manufacturer solved.

In the delivery of castings to the cleaning room, the operations of cleaning or fettling, and final delivery to the machine shop or shipping floor, all had their physical limitations which had to be overcome. However, in this phase of the work, the natural reluctance of the foundryman did not constitute so large a detriment.

An important lesson which the automobile manufacturer taught the American foundryman was the wisdom of breaking down or dividing operations. The tradition of the all-round moulder who mixed his own sand, rammed his own moulds and shook-out his own castings found little sympathy from the production-minded foundry executive. In consequence, except in the heavy-work foundries, the skilled moulder of the past generation is rare. Instead one finds a higher-paid class of labour, each man schooled and trained to some particular phase of his work and through constant practice, a master of certain routine. This situation has been criticised by many, but the answer is found in the higher standard of living made possible through increased production, higher wages and, indirectly, shorter hours of work. Obviously, a man who performs only a few individual operations in a chain must be alert and work intensively to keep ahead of the work which is coming down on him. All the operations are carefully timed, and although foundry workers in production shops work hard they are contented, and few of them would be willing to change for less exacting and lower-paid pursuits.

D. M. AVEY

Editor "The Foundry," Vice-Chairman A.F.A. Programme Committee).

American Practice in Motor-Car Foundries.

A brief outline of typical examples of mechanised foundries may be of interest. An automotive foundry will be considered first. Incoming raw materials usually are stocked in yards which are divided and classified so that the various classes of metal, fuel, sand, etc., are stored and divided. Iron is taken to the charging-floor by elevators, skip-hoist conveyors or travelling yard cranes either of the bridge or gantry type. Molten metal is delivered to the pouring floor by overhead monorail cranes, bridge-type cranes carrying heavier ladles or by storage battery trucks. In many instances metal is poured directly from the ladle to moulds as the latter are moved along on conveyors.

In the meantime sand is delivered to the preparation system of buckets mounted on cranes, by delivery cars pulled by storage battery trucks or by continuous conveyors with self-loading devices. The sand is mixed intensively, tempered or treated as the case may be, and delivered to continuous conveyors which continuously fill the hoppers, over different moulding stations.

Core sand similarly is treated and thoroughly mixed and delivered to overhead bins either by conveyors, dump trucks or crane-carried boxes. All moulding operations are divided so that each pattern is operated continuously upon a single machine. The moulds are assembled on moving conveyors. The drag is swung into place first, cores are set to jigs, and as the conveyors move along, the mould is closed, locked or wedged, poured and delivered direct to the shake-out station.

The flasks are picked up by crane hooks or special shake-out devices, the castings dropped upon moving conveyors or picked up by cranes and transported to the cleaning room. Gates and heads are knocked or cut off mechanically and the castings are sandblasted or tumbled and then taken by crane or conveyor to the point where they emerge from the foundry. In many instances the limiting factor on the application of conveying equipment in automotive foundries is the length of time required to cool each casting to a point where it can be cleaned. In some cases extensive overhead conveying systems carry the castings high in the air and keep them in motion until they reach a low enough temperature to be worked upon further.

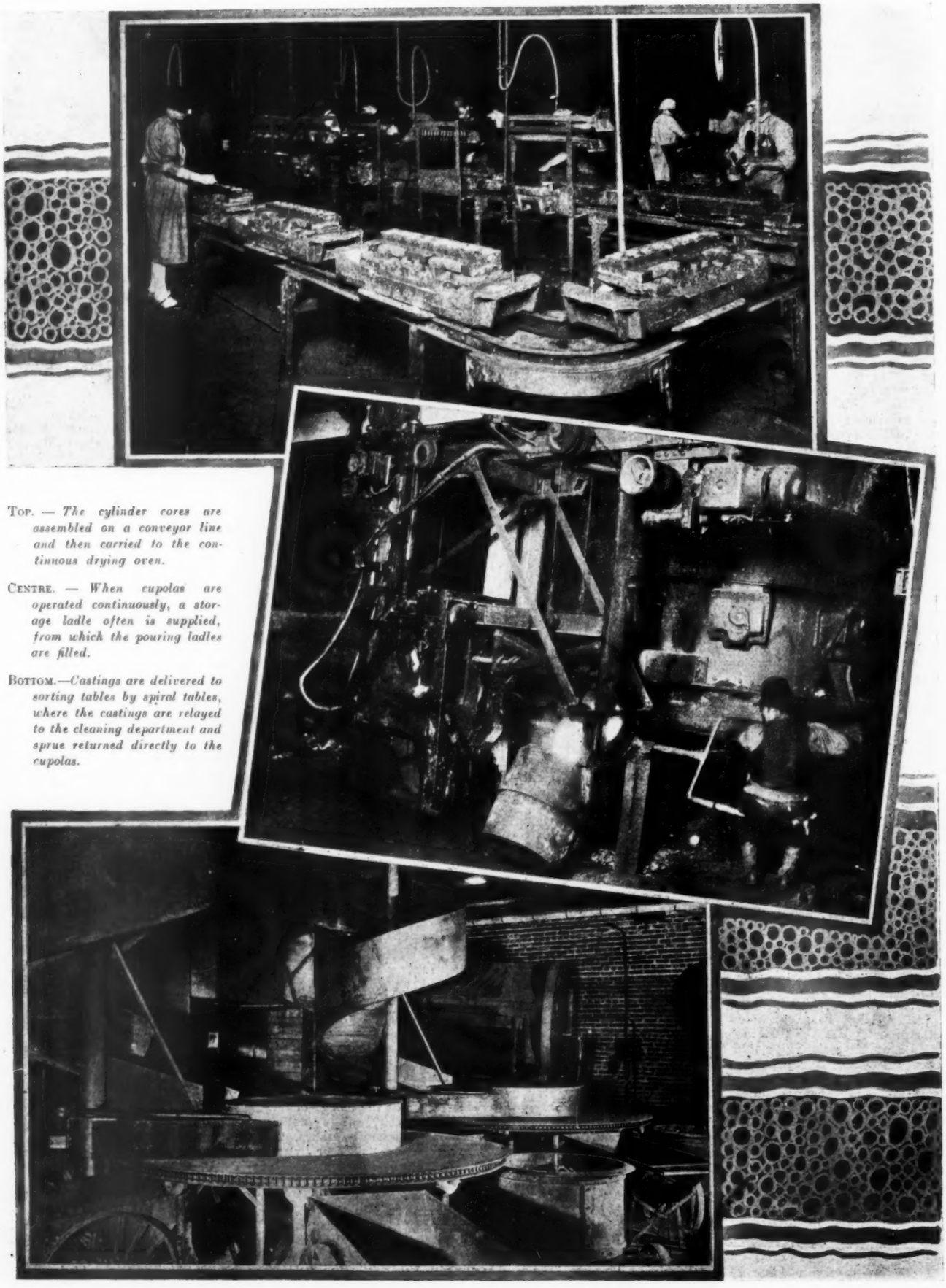
In the earlier applications of mechanical handling equipment, it was felt that the systems would be inelastic. In other words, it was believed that a breakdown in any one part of the cycle would stop the entire production. This difficulty has been overcome by duplication of units and by perfecting mechanical equipment to the point where a time-lost breakdown is rare.

Furthermore, without undue stress, it has been found possible seriously to increase the output of existing foundries. About two years ago a large automotive foundry was built with an estimated maximum production of 5,000 cylinder blocks and miscellaneous supplementary castings per day. This production was stepped up to 6,000 in response to increased demands from the manufacturing department, and recently to about 7,200 per day. The 6,000 output was reached without any addition to the handling or production equipment, but the additional 1,200 will require installation of additional machinery, installed on the first possible succeeding Sunday.

Three years ago this foundry was producing 2,100 cylinder blocks per day on each unit of its moulding and conveying equipment. A crew of 80 men, working on a space 40 by 260 ft., including the necessary gangway and storage facilities for cores, handled the work on this unit. With a production of 5,000 units per day this foundry poured 1,400 tons. With the increase to the 7,200 units, the output will require more than 1,800 tons per day.

Consider next the specialty shops making radiator and steam boilers for heating purposes. One of the most recent accomplishments in this line is represented by a foundry which in 1927 produced 85,000 tons of castings and in 1928 attained 125,000 tons with but slight additional floor space. The answer is found in the application of mechanical methods. Here, as in the case of automotive foundries, the incoming material is handled by cranes. Iron, coke, etc., are loaded in larry-cars, elevated to the cupola, and charged directly from the railway delivery trucks. With only four men, including the crane operator, 200 tons of metal plus 25 tons of coke is charged into two cupolas during a 9-hr. shift, at a cost per ton of slightly more than fivepence. Metal for the larger boiler sections is delivered to the pouring floors in ladles holding from 1,000 to 1,600 lbs. These ladles are carried on telpher-operated monorail cranes. The larger castings are poured directly, while in the case of light work the heavier ladles are set on trunnions, and the moulds are poured from 500-lb. ladles.

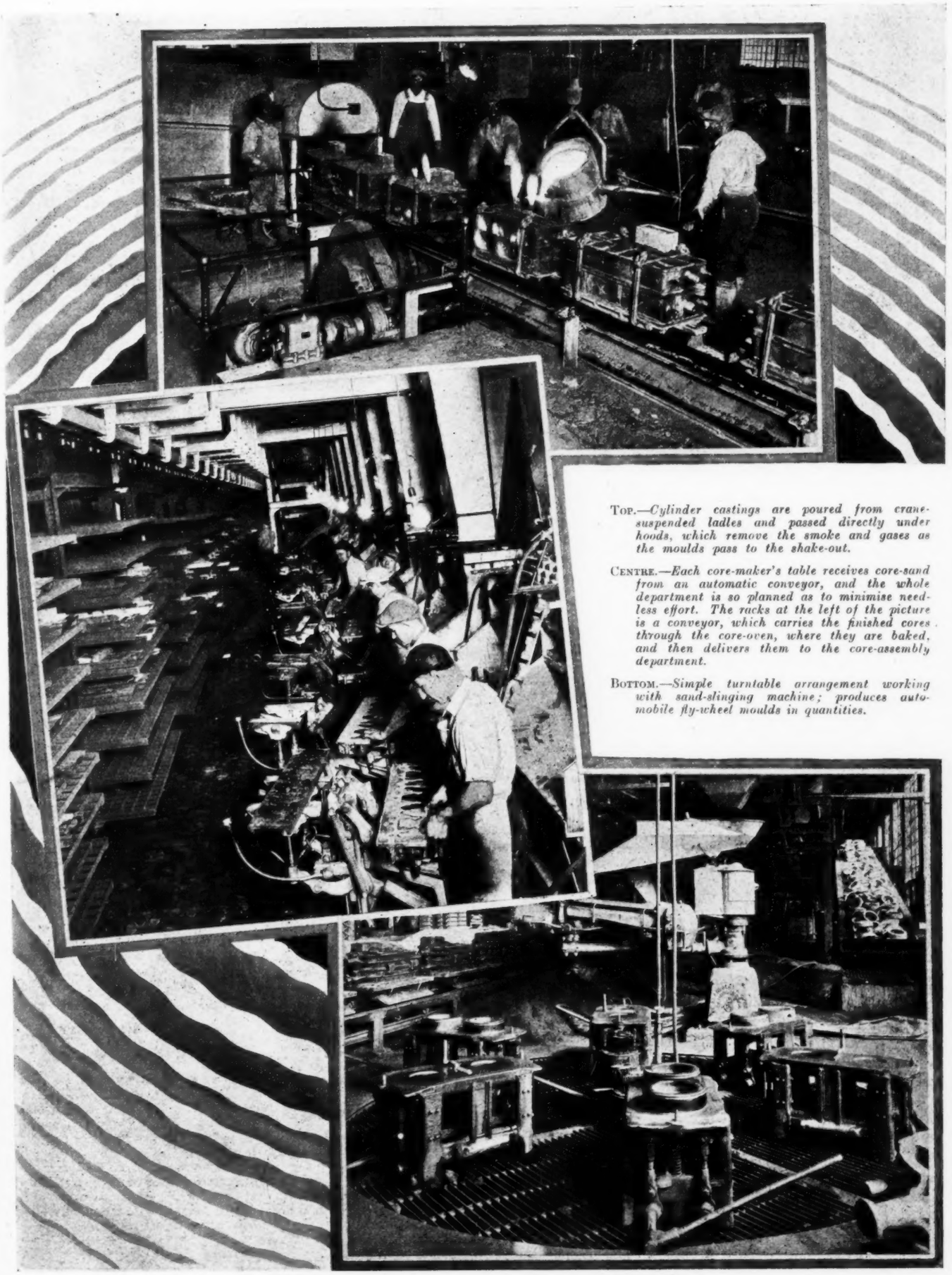
The large sections are moulded on platforms, placed on roller conveyors, shoved along and



TOP. — *The cylinder cores are assembled on a conveyor line and then carried to the continuous drying oven.*

CENTRE. — *When cupolas are operated continuously, a storage ladle often is supplied, from which the pouring ladles are filled.*

BOTTOM.—*Castings are delivered to sorting tables by spiral tables, where the castings are relayed to the cleaning department and sprue returned directly to the cupolas.*

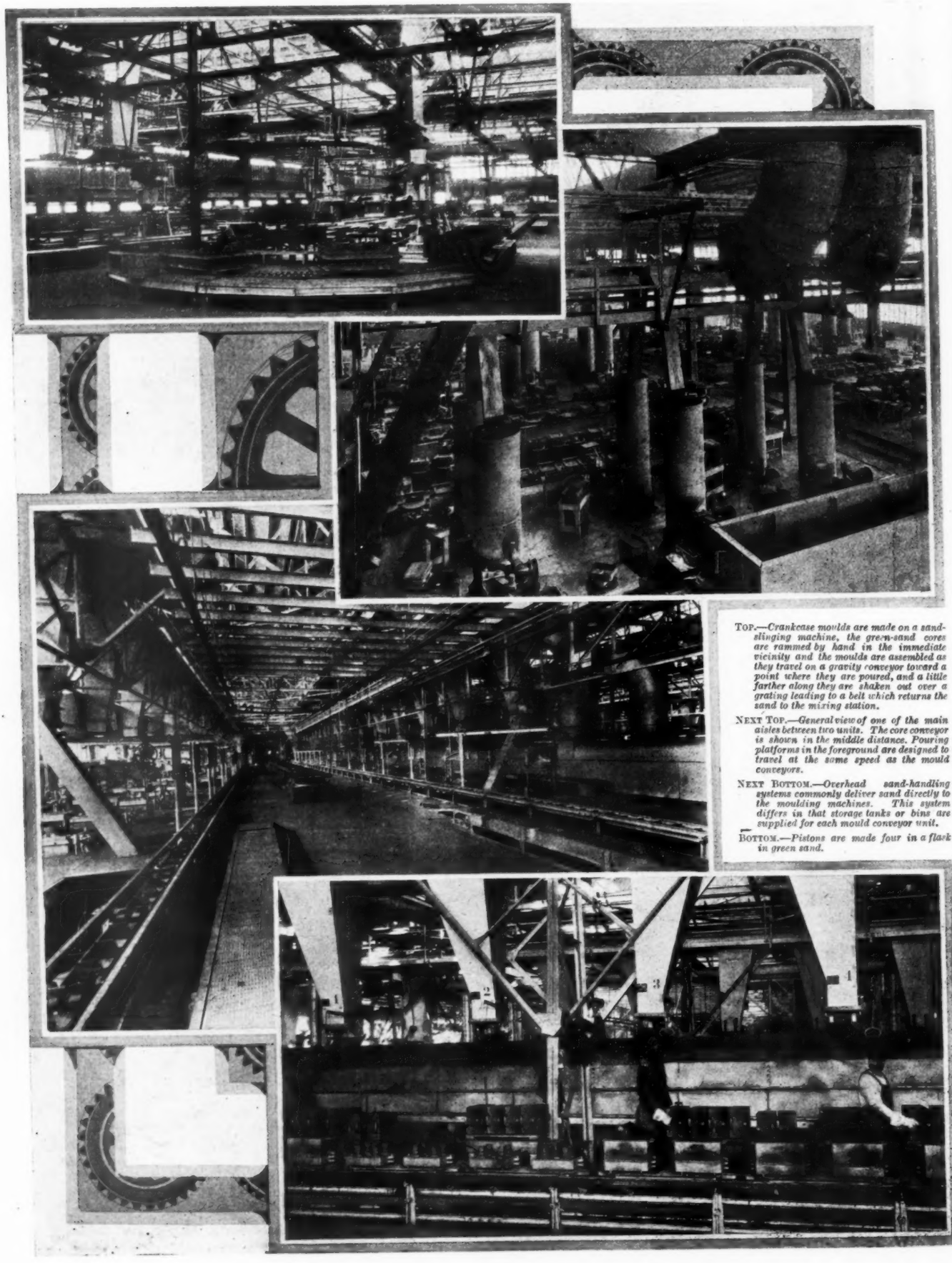


Top.—*Cylinder castings are poured from crane-suspended ladles and passed directly under hoods, which remove the smoke and gases as the moulds pass to the shake-out.*

Centre.—*Each core-maker's table receives core-sand from an automatic conveyor, and the whole department is so planned as to minimise needless effort. The racks at the left of the picture is a conveyor, which carries the finished cores through the core-oven, where they are baked, and then delivers them to the core-assembly department.*

Bottom.—*Simple turntable arrangement working with sand-slinging machine; produces automobile fly-wheel moulds in quantities.*

XUM



TOP.—*Crankcase moulds are made on a sand-slinging machine, the green-sand cores are rammed by hand in the immediate vicinity and the moulds are assembled as they travel on a gravity conveyor toward a point where they are poured, and a little farther along they are shaken out over a grating leading to a belt which returns the sand to the mixing station.*

NEXT TOP.—*General view of one of the main aisles between two units. The core conveyor is shown in the middle distance. Pouring platforms in the foreground are designed to travel at the same speed as the mould conveyors.*

NEXT BOTTOM.—*Overhead sand-handling systems commonly deliver sand directly to the moulding machines. This system differs in that storage tanks or bins are supplied for each mould conveyor unit.*

BOTTOM.—*Pistons are made four in a flask in green sand.*

poured on the conveyors, the shake-out flasks and boards returned, and the castings piled on trucks for cooling before being carried to the sand-blast department on bogies, which are drawn by electric storage-battery trucks. Here the castings are piled after sand-blasting, tested, machined and assembled.

An earlier radiator foundry operated by the same company used a large vertical-wheel conveyor, performing its moulding operations on a level with the axis of the wheel, placing the moulds on the wheel, and permitting them to go up and over the top to the pouring station, which also was on a level with the axis, and then to pass down below to the shake-out. Sand was reconditioned and conveyed to hoppers above the moulding station.

Another type of radiator shop utilises a conveyor for its moulds, but passes a truck under one station, where the facing sand is riddled over the pattern, thence to a second sand-bin, where a predetermined amount of backing sand is dropped in place, and next under a mechanical rammer, with the rammers operated by eccentrics to pack the sand over the entire face of the mould. The trucks then are passed along, cored, closed and poured under a mechanical hold-down or top-plate. This rig produces a mould containing two sections of a three-column radiator every 45 secs. Numerous other examples might be given of the application of mechanical methods to American foundry practice, ranging from shops making ¼-lb. electrical castings to heavy railway-truck wheels. All of these have points in common and also widely differing details. A general summary of types of equipment employed might be of interest.

In handling raw materials entering the plant, overhead travelling cranes, monorails, trucks and cars, electric magnets and conveyors all find their place and service. For charging furnaces, cranes or special machines to introduce metal into the cupola, air furnace, or open hearth, are often employed. Similarly, dump-cars of special type, drop-bottom buckets or boxes and other devices have been widely used.

In electric-steel foundries special charging devices are also available. One or two foundries have a turntable device with a stationary cover or top carrying the electrodes which may be lifted free to permit the interchange of a newly-charged furnace with one which has just completed its operation, by merely revolving the turntable through an angle of 180 degrees. In handling metal from the furnace to the pouring-floor, overhead cranes, telpher or hand-operated monorails, ladle-cars or electric-storage battery trucks and locomotive-drawn ladle-cars all find their application.

Various types of moulding machines have been developed and perfected under competitive conditions. The main types are the squeezer, bumper or jar-ram, pneumatic or mechanically-operated rammers, sand-throwing and sand-blowing machines. All of these are as familiar abroad as they are in America. Conveyors upon which moulds are assembled are of many types, varying from the common roller-table, in many cases equipped with ball or roller bearings, chain or cog-operated tables moving either on rollers or sliding upon rails, and, of course, the car-type conveyor system, which was perhaps the first to find acceptance.

Solving Sand Problems.

Sand-preparation systems range from the screening types to the pan type and the revolving-drum or belt-aerating equipment.

Sand-conveying equipment likewise differs widely under different conditions. The flat belt conveyor with intersecting ploughs to deflect the sand to waiting bins, perhaps is the most widely used. Another type has a series of vanes or flat ploughs which are rigid when pulled forward, but hinge back over the sand, as a reciprocating motion of the entire chain of vanes moves the mass of sand in the direction desired.

American Cleaning Methods.

Castings are handled on cars or trucks, are picked up in tote boxes by cranes and conveyed about the shop, or in many cases are hooked directly upon overhead conveyors and move over a considerable distance from the shake-out to the cleaning departments. Mechanical shake-out ranging from a modification of the bumper idea to the giant vibrators which pick up the entire flask and shake the sand free are to be found in practically every production foundry. A more recent type is attached directly to the flask as it rests on the conveyor, and a vibrator shakes the sand free. In the cleaning department conveyors in many cases carry the castings along from one operation to another through the chipping, grinding and sand-blasting operation.

All of these features of equipment in American foundry practice have been developed by copying and improving new ideas. They are due in no small measure to the spirit of co-operation which actuates the entire industry. This spirit pervades the foundry industry throughout the world and finds its exemplification in the International Congress opening in London next week. American foundrymen have learned much from their European confrères. Many of America's largest and most successful establishments are owned or operated by men who have behind them the tradition and teaching of the Old World. Consequently, they acknowledge a debt to the precepts of others. They throw wide their doors to foundrymen from beyond the seas, to those from another city or to their competitor next door. They are proud of their accomplishment, but, recognising the benefit of interchange of opinion, are attentive to every word of suggestion and teaching from other foundrymen throughout the world.

Overseas Visitors in the Midlands.

Birmingham Works Visit and Civic Reception.

The overseas foundrymen attending the International Convention paid a visit to the Birmingham district in the course of their pre-convention tour. On arrival at Birmingham they were met at Snow Hill Station by the members of the Branch Council, headed by the Branch-President (Mr. E. H. Tyson). The programme of works visits, etc., was commenced next morning, when the party were taken to the famous Soho Foundry of W. & T. Avery, Limited. Here they were received by Mr. Ritchie, of the Publicity Department, and the historical development of Soho Foundry from the days of Boulton and Watt was outlined prior to a tour of the workshops and foundry. In acknowledging the welcome given by Sir Gilbert Vyle, MR. S. T. JOHNSTON (President A.F.A.) stated that the wonderful traditions upon which British industry was built were exemplified in the works they had just seen. The visitors were photographed in a group on arrival at the works and were pleasantly surprised when each received a copy of the photograph some ninety minutes later. The ladies of the party visited the City Museum and Art Gallery and other places of interest during the morning.

The party were entertained to luncheon at the Council House by the Lord Mayor of Birmingham (Alderman W. Byng Kenrick, J.P.) and the Lady Mayoress, among others present being Sir Gilbert C. Vyle, Emer. Prof. T. Turner, Mr. E. Player (Sterling Metals, Limited, Coventry), and the Branch-President. The Lord Mayor, in welcoming the guests, stated that he was a foundryman himself and hoped that their visit to Birmingham would show them something of the British foundry industry. He thought that the foundry industry was rather like the cat with many lives, as it was, according to some people, always on the point of extinction through some new method of metal-working but always seemed to come to life again in another direction and was still thriving. In reply Mr. S. W. Utley (Chairman of the Detroit Chamber of Commerce) outlined the ideals of modern commerce, which, he said, would prepare the way to universal peace. He contrasted the unstable rise and fall of might as exemplified by Napoleon with the stable rise and continued prosperity of industry from the days of Boulton and Watt.

Visit to Godiva's City.

After luncheon the visitors proceeded to Coventry to visit the foundries of Sterling Metals, Limited, where they were met by Mr. E. Player (managing director). The visitors were greatly impressed by the ferrous and non-ferrous foundry practice, which they stated was equal to the best practice in the United States. The ladies of the party visited the places of historic interest in Coventry under the guidance of Mr. Carey Hill, and tea was taken by all at the Sterling Metals, Limited.

The party then proceeded to historic Astley Castle, the home of two Queens of England, and also visited Astley Church, with its ancient history and unique interior. Arbury Hall and Park, the home of George Eliot, were also visited, and the party returned to Coventry for dinner. Prior to the dinner the Mayor of Coventry (Alderman A. J. Makepeace, J.P.) and the Mayoress received the guests, among whom were Mr. L. H. Pomeroy (General Manager, Daimler Company, Limited), Mr. Viner (British Piston Ring Company, Limited), Mr. E. Player, Mr. F. H. Hurren (Coventry Malleable and Aluminium, Limited), and Mr. Kelway (Alfred Herbert, Limited).

Mr. E. H. Tyson (Branch-President) was in the chair.

After dinner, the MAYOR, in welcoming the visitors to Coventry, stated that Coventry was a city with an historic record which was both political and industrial. He reminded the visitors that Coventry was famed throughout the world for silks and ribbons, watches, bicycles, motor-cars, machine tools and artificial silk, as well as for Lady Godiva. MR. A. HARLEY (Daimler Company, Limited) also welcomed the visitors on behalf of the industry of the city.

MR. H. COLE-ESTEP, replying to the welcome, said that he always thought that Coventry was a place where one had to "peep" to see things. (Laughter.) He had found that day, however, that the doors of Coventry and of Coventry's industry were thrown open wide to them. He had understood as a boy that to be sent to Coventry was a disgraceful business, but he could not say that now. Mr. Estep then outlined his views on the reasons for America's industrial prosperity. They found in America, he said, that paying high wages resulted in a greater amount of money being spent by the community and consequently there was greater demand for commodities and increased trade. Give a man a low wage and he will buy a bicycle, but give him a high wage and he will buy a motor-car. That was an argument which he felt should appeal to Coventry manufacturers.

During the evening MISS MARJORIE SMITH entertained the guests with songs.

New Companies.

Adderbury Park Farm, Limited, Adderbury, Oxon.—Capital £5,000. Ironmasters, etc.

Technical Investigations, Limited, 27, Queen Victoria Street, London, E.C.—Capital £10,000.

Latent Laboratories, Limited, Willing House, Gray's Inn Road, London, W.C.—Capital £5,000. Industrial chemists and engineers, etc. Directors: R. Brownlow and G. Ouston.

Bolide (Foreign), Limited.—Capital £9,000. Iron-founders, etc. Directors: J. G. de Jetley-Marks, 43, Mapesbury Road, London, N.W.; R. Price, A. O. Carter, J. Richards and L. Mendel.

International Foundry Trades Exhibition.

REPRESENTATIVE DISPLAY AT THE ROYAL AGRICULTURAL HALL.

(*Continued from page 428.*)

Badische Maschinenfabrik und Eisengiesserei.—This is one of the most attractive and interesting Stands in the Exhibition. This is only as it should be, as the firm, whose works are at Durlach, in Germany, claim to be the largest manufacturers of foundry equipment in the world. They have recently appointed Messrs. John A. Smeeton, Limited, of 15, Victoria Street, London, S.W.1, as the British agents. Amongst the more prominent exhibits are to be noted:—

Mr. J. A. Smeeton, M.I.Mech.E., *British Agent for Badische Maschinenfabrik.*

Compressed-air Sand-throwing Machine.—This machine is the result of two years' practical experimental work, and for which German patents have been obtained and British patents applied for. The machine, as now designed and demonstrated on the Stand, combines in a self-contained manner all the details of design and construction necessary to make it a valuable working unit in all large foundries. It is fitted with a sand-screening and elevating unit, which lifts the sand from the floor level and passes it over a magnetic separator, from whence it goes into the main receiver. The sand then passes down the receiver, under control, to the base, where it falls into a small receptacle and comes into contact with the compressed-air stream, which forces the sand along a specially-designed hose. Upon the end of this is fixed a patent nozzle through which the sand is blown under pressure into the mould. The operator working the nozzle can control both the quantity and pressure of the sand from the nozzle.

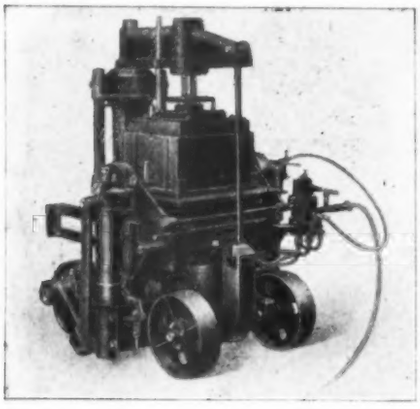


Fig. 36.—Portable Moulding Machine, by the Badische Maschinenfabrik.

This machine works normally within a radius of 35 ft., but by extending the hose and the air pressure it is possible to fill any mould within a radius of 150 ft. It is, therefore, possible, without moving the machine from its fixed place in the foundry, to fill all the moulds in a very large foundry with one machine. Strong flexible-expanding arms are attached to the machine for carrying the sand-hose, which allow the operator free movement, with a minimum of exertion, when filling the moulds. The machine has a very large hourly capacity and fills the moulds compactly with sand even in the most complicated castings, as the nozzle discharges the sand both vertically and horizontally as required.

The machine is strongly built in every detail, and can be used with any suitable quality of sand without fear of breakdown through clogging. It is claimed that if the machine is used constantly it will pay for itself in one year by the saving in moulders' wages alone. No ramming of any sort or kind is required, either during or after the filling of the mould. The motors and other gear for driving the machine are all fitted on to the machine in easily-accessible positions for attention, repairs and general maintenance, with the exception of the air-compressor, which is fixed separately from but adjacent to the machine for regulating volume and pressure.

In conjunction with this machine there is a small compressed-air crane for lifting and emptying the moulding boxes. This crane works very fast and is stated to be cheaper to run than an electric crane of similar lifting capacity. A large compressed-air receiver is placed on the stand for storing the high-pressure air supplied from the central air-compressor plant. A reducing valve is fitted to the receiver for reducing the pressure of air as required by the various machines.

Sand-preparing Plant.—This machine is of special design and is complete in every particular. The moulding sand is lifted by elevator and is then passed over a magnetic separator, thence into mixer, and then down the shute into the main hopper, which holds two to three cub. yards. From this hopper the sand falls automatically down three shutes, each fitted with a special device to allow a definite quantity of sand to fall into the moulding box of the three shockless jolting-moulding machines being served. After moulding, the sand is emptied over a grid, when it drops on to a conveyor below floor level and is thus again brought to the elevator buckets for re-using. The machine is shown constantly working in conjunction with the moulding machines, and complete access is given by strongly-built ladders to every working part for inspection, lubrication and repairs. The whole plant is run by a series of electric motors mounted on the machines, together with the controllers and switches.

Moulding Machines.—Three different types of shockless jolting-moulding machines will be constantly worked, demonstrating the simplicity, ease and speed of working. The small machine is of the latest design, by which the jolting and top ramming take place simultaneously and thus eliminate the necessity for pressing the sand by operating the top plate independently. All these machines and also the portable core-moulding machine, which is also shown, contain the latest developments. They are all substantially built with a view to continuous working on large outputs, with a minimum chance of breaking down.

Tumbling Barrel.—This large machine is a new type and is of very solid construction throughout. It is driven by a self-contained vertical motor of 13 h.p. It is arranged for cleaning quite large castings of simple form. It is working constantly to demonstrate the efficiency of production. Owing to the self-contained drive it can be placed at any part of the foundry away from the driving shafts.

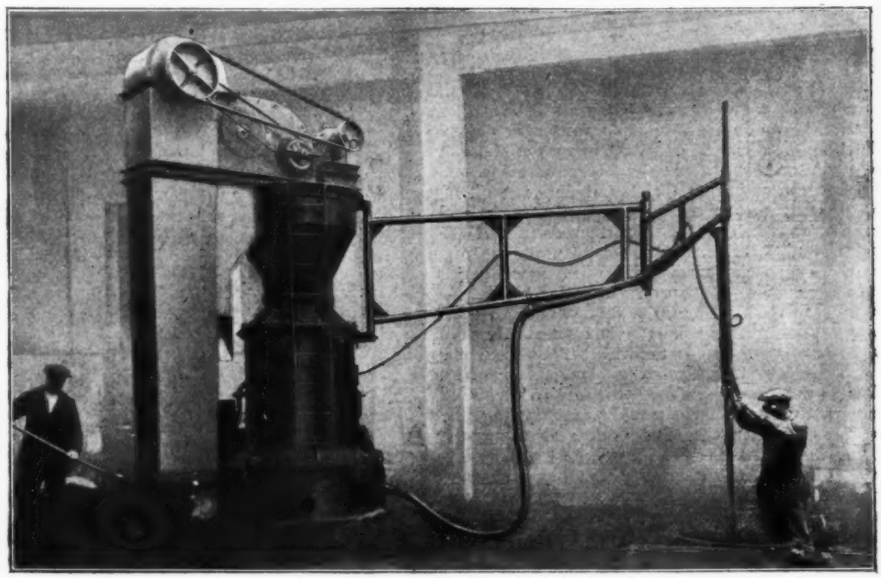


Fig. 37.—Compressed Air Sand-throwing machine.

Sand Sifter and Thrower.—This machine is also of recent design and is of the portable type. It has a self-contained motor of 2 h.p. mounted on the framework and suitably covered against and protected against flying sand. It is most effective in its operation and thoroughly breaks hard lumpy sand, extracts foreign matter, mixes and aerates the sand and throws it back on to the floor as required. It can be wheeled from point to point as and when desired. The motor is driven from wall plugs placed in suitable positions along the foundry wall.

Sand-blasting Plant.—This machine is of the revolving-drum type, and represents their latest design of machine for cleaning small and intricate castings, machine tools and other materials from which it is desired to remove sand, scale or other surface deposits. The interior of the barrel is so arranged as to cause the contents constantly to change position and thus allows the blasting sand to impinge on every surface. The sand-blast nozzles are safely housed in the hollow trunnions. All the sand is removed automatically and passed through a series of

screens, the blasting sand being returned for re-use to the small receptacles fitted on each end of the machine. The method of driving by eccentrics and pawls is novel, and gives a jerking movement to the contents of the barrel. It is all controlled by one man from the front by a series of levers, all of which are easily accessible. The dust is removed through the hollow trunnions which are connected to a small suction fan, so that the machine works dustlessly at all times. This machine is not working, but

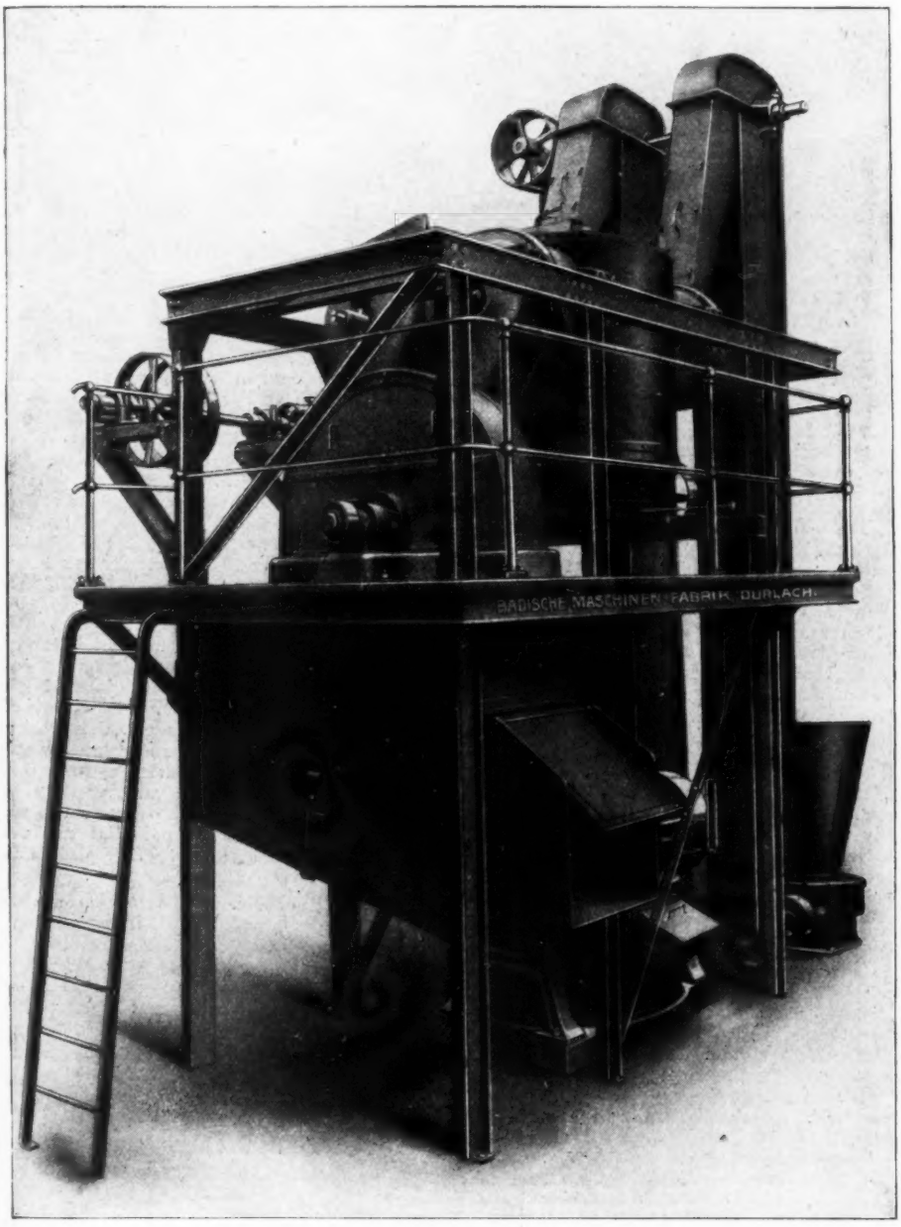


FIG. 38.—AUTOMATIC SAND-PREPARING PLANT.

can be thoroughly examined in regard to details of construction.

Portable Heater for Stoves and Floor Moulds.—A half-section of this machine is shown to demonstrate the principle by which it works. This apparatus has been specially designed for the purpose of drying and heating large moulds made in or laid on the foundry floor, or, alternatively, for building against the walls of core- and mould-drying or heating stoves. It consists of a self-contained unit forming a semi-gas producer fired by coke. The coke is introduced through a door at the top of the apparatus, and the burning of the coke forms a rich CO gas. A grate at the bottom is arranged for continuous cleaning and for allowing the primary combustion air to flow freely into the producer body, as shown by lines. A small regulatable door is fixed on the side at the bottom for introducing secondary combustion air for converting the gas into CO_2 gas. The hot CO_2 gas passes from the producer at the side through an aperture where it comes into contact at right angles with pressure air in a chamber. The air is supplied by a small fan driven by a small ½ h.p. motor fixed to the apparatus. This pressure air, which can be regulated in regard to volume by a small damper, is heated to the requisite temperature and passes down a channel into the mould or into the distributing flue of the stove in a dustless condition. A small observation door is fitted on the side opposite the gas outlet so that the action of the apparatus can be controlled and the gas passage kept clear of coke ash or other matter.

The casing of the producer is lined with insulating bricks to prevent the loss of heat by radiation. The stove is made in various standard sizes to suit requirements. It is economical in fuel consumption and efficient in its heating capacity. As the heated air is entirely free from dust or any other impurity owing to the fact that coke is used instead of coal, no cleaning of the moulds is necessary as in most other types of heaters.

A 4-ton "Collin" patent tilting ladle is also shown on the Stand. The advantages of this type of ladle are so well known by the foundry industry that it is unnecessary to give a further detailed description thereof.

Mr. John A. Smeeton is personally taking charge of the Stand, and with him will be associated a number of experts from the Durlach works.

Thos. W. Ward, Limited.—This Stand itself covers about 300 sq. ft. of floor space, the outside facia being about 10 ft. high and the balustrade railing, with the firm's monogram in relief, and embraces three sides. The various samples of pig-iron and coke, which are the chief exhibits, are arranged in an attractive manner, mostly in showcases. The specimens of pig-iron include Shotts' famous Scotch No. 1 and No. 3 pig-irons, and Bolckow Vaughan's well-known Cleveland pig-irons in foundry, forge and basic qualities. There are also samples of the well-known Mansfield moulding sand, supplied from their own quarries. There are some interesting specimens of castings made from the various pig-irons.

The firm's head office is at Albion Works, Saville Street, Sheffield, but they possess works and offices in every foundry centre in Great Britain. The London office is located at 116, Fenchurch Street, E.C.5.

British Perlit Licensees' Association.—Typical castings, made by the Lanz Perlit process, together with data on their properties, results, etc., are exhibited at this Stand. For high-duty jobs and such purposes as Diesel-engine cylinders, cylinder heads, pistons, liners, and such like, Perlit castings are peculiarly suitable by virtue of high strength, resistance to shock, non-growth properties and freedom from both internal stresses and porosity. Uniformity of strength and structure throughout all sections is another favourable characteristic of these castings.

Specimens of sectioned Perlit castings are shown, and these, together with micro- and macro-structures afford proof of the above qualities.

One feature on the Stand shows Perlit iron as used for permanent moulds for a wide range of non-ferrous metals. In other examples it is used because its superior reliability allows a significant reduction in weight of the castings.

The offices of the Association are at 3, Central Buildings, Westminster, S.W.1. Mr. Grimshaw Martin, Mr. H. J. Young and Mr. Hall are in attendance on the Stand.

E. P. Barrus, Limited.—The principal feature at this Stand is a range of Stanley electric drills and grinders. The electric drills are of a compact and totally-enclosed design, and will run for considerable periods at full load without overheating. They are made in ten sizes, ranging from ¼- to ⅞-in. drill capacity and may be worked at any voltage. The grinders are supplied with two 6-in. wheels—one fine, one coarse—and it is stated that there is no vibration even when the wheels are revolving at 3,450 r.p.m. Other tools being exhibited are Starrett fine mechanical tools, Cleveland drills and reamers, Porter bolt clippers and shear cutters.

The office of the firm is at 35-37, Upper Thames Street, London, E.C.4.

R. W. McIlvaine Company.—This firm has for many years manufactured sand-handling and mould-conveying equipment for foundries, and its experience and intimate knowledge of the practical foundryman's needs has resulted in the production of a *Moisture Meter*. This instrument is employed for instantly determining the moisture content of either heap or floor sand. Although it is electrically operated, there

are no external wires, and for this reason, it is as simple to operate as a shovel. By lightly pressing the instrument into the sand, the amount of moisture present is instantly indicated by a meter on the handle. It is in actual operation at the Stand, and its uses and construction are being demonstrated and explained. Photographs of conveying equipment installed by the firm at several prominent American foundries are also on display.

The head office is at 53, West Jackson Boulevard, Chicago, U.S.A., and the London agent is Mr. S. G. Evans, of 22, Laurence Pounteney Lane, E.C.4.

John Macdonald & Son.—This firm are exhibiting a new model of their well-known range of "Ajax" moulding machines. These machines are made for operation by mechanical, hydraulic and pneumatic power. The exhibit shown here, however, is a No. 1 "Ajax" jarring and pattern-draw moulding machine, operated by compressed air.

This machine has been designed to meet the requirements of smaller steel, iron, brass and aluminium foundries, but it is in operation jolting a total weight of box and sand amounting to 2 cwts. This machine takes boxes from a minimum of 14 in. by 12 in. to a maximum of 18 in. by 16 in.; it is fitted with the "Ajax" patent control valve, pilot and jarring valve and with 1-in. vibrator. There are also shown on the Stand photographs of various other machines up to No. 24 size, which has a table approximately 9 ft. by 8 ft. and a jarring capacity of 10 tons.

A full range of "F.A.M." pneumatic hammers is also shown. Its value lies in the simplicity of the valve mechanism, which is fully shown in a hammer cut in halves to show the internal construction. It will be seen from this that the valve in question is different from other makes, *i.e.*, it acts as a poppet valve, and not as a slide valve; as a result the maximum motion of the valve is reduced to a minimum, and moves freely with negligible friction, and, having no involved air passage, eliminates wire drawing. The barrel, piston and sleeve, which are the remaining moving parts, are accurately made, hardened and ground, giving the longest possible life.

The head office is at Nitshill, near Glasgow. Mr. Hunter is in attendance at the Stand.

Gustav Zimmermann Engineering Works.—The machines on this Stand are all shown in operation. Amongst moulding machines the more important are:—A *Shockless Jolt-squeeze Stripping-plate Machine, Type S.R.P.2*, for moulding copes. The free-drop jolter is characterised by its "clinging" blow. The capacity of the machine is 650 lbs.; the squeezing power, 11,000 lbs; the lifting stroke, 10 in.; and the maximum flask surface, 400 sq. in.

A *Jolt-squeeze Roll-over Moulding Machine, Type R.P.W.2*, for moulding drags.—This is a companion machine to the S.R.P.2, but has a lower squeezing power (7,700 lbs.) and a deeper lift (12 in.).

A *Portable Jolt-squeeze Moulding Machine, Type* F.R.1, for flasks measuring up to 350 sq. in. It jolts and squeezes simultaneously, finishing the mould in a few seconds only. The lifting stroke is 5 in.

A novelty is embodied in a moulding machine which vibrates the mould from both sides, without jolting and squeezing. Its lifting stroke is 3 in.

Two core-making machines are shown, one is a "Revolt" blowing machine for complicated cores and the other a vibrating machine for the simpler variety.

The head office is at 290, Theodor Strasse, Düsseldorf.

J. Arthur Hartley.—The only exhibit on this Stand is yet another of these machines which perform the dual function of a riddle and aerate foundry sands. This particular model is of small dimensions, compact, simple in operation and easily portable; therefore, it can be taken quickly to any crowded moulding floor or job, thus eliminating unnecessary handling of the sand. It is of substantial construction and made of the highest grade materials. The chrome-nickel steel shaft runs on S.K.F. ball bearings, the wheels on roller bearings. The shaking mechanism has bronze bushings. The running parts are made dust proof. The machine housing is a manganese steel casting. The solid and simple construction of and the carefully selected materials used in the machine ensure long life even under unusually severe operating conditions.

The offices of Mr. Hartley are situated at 15, Claverdale Road, Brixton. Mr. Hartley is personally in attendance on the Stand.

The Gledhill-Brook Time Recorders, Limited.—Founders have in recent years been forced to study exceedingly carefully the question of costs. The taking of the operatives' time has long been a *sine qua non*, but now this system has been extended to job costing, and visitors are well advised to discuss costing problems with the experts on the Stand, as the scope of machines is being constantly widened.

The offices are Empire Works, Huddersfield.

T. E. Salter, Limited.—This well-known firm is showing material of interest to two sections of the industry. For the fettling shop there is a fine range of emery grinders, with self-contained dust-collecting sets; whilst for the melting department there are cupola fans and motor-fan sets.

The works are located at Bloomfield, Tipton, Staffs.

Black & Decker, Limited.—Here are being shown a range of portable electric drills, tappers, sanders, screwdrivers and grinders, For the fettling shop there is an electric swing-frame grinder for use with Bakelite-bonded high-speed grinding wheels, up to 10,000 surface ft. per min., and several electric floor grinders and buffers of the pedestal type.

Their works are on the Trading Estate at Slough, Bucks.

H. C. Slingsby.—On this Stand is a very complete collection of trucks, stackers, ladders, handcarts, barrows, both steel and wood, but mainly trucks. Of these, the variety exhibited is extremely wide and covers in a complete manner most modern industrial requirements.

Their head offices are at 89, Kingsway, London, W.C.2.

Rene Volet, Limited.—The R.V. universal grinder is the exhibit of major interest to foundry owners, as it can be fitted on any machine tools fitted with a 1-h.p. motor. It is shown together with all accessories for internal and external grinding. Another useful tool is a portable electric trimmer, developing 1 h.p., for fettling castings.

The R.V. portable electric air compressor, fitted with an effective air filter, is a machine in which weight has been cut to a minimum. This type of machine is rapidly assuming increasing importance to the foundry industry.

The offices are situated at 242, Goswell Road, London, E.C.

Allen-Liversidge, Limited.—The department for which this firm caters, so far as the foundry industry is concerned, is something of a closed book in technical discussion. Yet all steel founders must realise that no foundry has reached perfection. Moreover, it is now possible to use the equipment shown on this Stand for removing runners and risers on steel and other types of castings. Both acetylene- and electric-welding plants are being shown. The wealth of experience possessed by this firm makes their machines of exceptional interest to the trade.

Their head office is located at Victoria Station House, Westminster, S.W.1. Recently a fine new works has been erected at Cricklewood.

Blackfriars Foundry Requisite Company, Limited.—This firm are exhibiting "Du-Ram" steel-moulding boxes, made by J. W. Sadler & Company, Bradford, for whom they are Southern agents.

Some of its main features are that it is made from best mild steel section ($\frac{3}{16}$ in. and $\frac{1}{4}$ in.), being light to handle but of very rigid design for rough usage. It incorporates a special method of building up, by means of a sand-gripping device fixed to the sides of the boxes, which make it a complete homogeneous unit equal in rigidity to cast-iron boxes. All boxes ae drilled to jig, thus interchangeability is certain, especially as they are machined on face and back.

Other exhibits include the well-known "Glutrin" range of products; plumbago; a speciality known as waterproof "Stripoline" parting powder, which is particularly suitable for metal pattern-plate moulding, red sand, silica sand, Kent yellow sand, etc., supplemented by a representative selection of all foundry furnishings, such as shovels, sieves, brushes, bellows, etc.

It is interesting to note that the firm acts as southern agents for Constructional Engineering Company, Limited, Birmingham; J. & J. Dyson, Limited, Sheffield, Chesterfield and Stannington; Britannia Foundry Company, Limited, Coventry; J. W. Sadler & Company, Limited, Bradford; and T. Fearnley Allen & Sons, Birmingham. Mr. F. Barraball and Mr. Wells are in attendance at the Stand.

The head office is at 34, Norfolk Street, Strand, London, W.C.2.

Glasgow's Value to Dominions.

Mr. H. M. Ford, secretary of the Clyde Trust, has just returned after a ten months' itinerary of Australia and New Zealand. Mr. Ford embarked on the tour on behalf of the Clyde Trust in August of last year. The object of the mission, with which the Glasgow Corportaion and the Chamber of Commerce associated themselves, was to direct the attention of producers in the two Dominions to the value to them of the Glasgow market, serving a population of six millions, and also the big potential markets available in the areas of Liverpool and Manchester.

Another part of Mr. Ford's mission was to direct attention to Scotland's industries and manufactures, and to plead for reciprocal trade. During the tour Mr. Ford addressed 128 public meetings; received 117 deputations; dictated 73 press interviews; 33 press articles; broadcast 7 times; had over two thousand discussions relative to his mission, and travelled 43,000 miles by land and sea.

International Foundry Co-Operation.

We most sincerely regret that in Mr. Cole-Estep's article printed in our last issue, and entitled "How the Foundrymen of the World Co-operate," we find but passing mention of the initiative displayed by the first chairman of the International Foundrymen's Committee. We feel for the sake of historical accuracy the whole credit for the rationalisation of the international business of the foundry industry should be given to Mr. Ropsy. Again, insufficient credit has been given to Dr. Werner, the second president. Dr. Werner has devoted much care, time and expense to the maintenance of the structure created by Mr. Paul Ropsy. We realise that Mr. Estep has reviewed the general aspects of this co-operation—the factors which led up to it—rather than the concrete realisation.

Some Interrelationships in Grey Iron Metallurgy.*

By J. W. Bolton, M.Sc., The Lunkenheimer Co., Cincinnati, Ohio.

Discussing relationship between strength and composition, J. G. Pearce[1] said: "If these (researches) can be shown to correlate (tests, working properties, and operating conditions) even for a single set of melting conditions, a great step forward in foundry control becomes possible." The present state of knowledge of grey cast iron as an engineering material generally is recognised as chaotic. A great deal of valuable quantitative research has been carried out. In the absence of intensive effort toward exacting correlation of this material, most of the present-day conclusions are but qualitative. This condition is understood by all grey iron metallurgists. Technical societies in America are devoting much time to study of the problems involved. This work undoubtedly will bring about major changes in specifications and methods of testing. With more accurate knowledge of the engineering properties of various grades of iron, the character and quality of product will become more nearly standardised. The engineer will make greater use of grey iron castings to the degree that he is informed of its desirable properties. Scientific foundrymen hold no brief for this or that engineering material. The best material is that which fully satisfies engineering requirements in the most economic manner. For this purpose it may be bronze, for that steel, and for the other, grey iron. However, foundrymen must seek accurate knowledge, that they may select without prejudice—for this alone spells real progress. With no intent of particular selection, attention is directed to the value of Papers of the type lately contributed by J. G. Partridge.[2]

This Paper deals with schemes of correlation which the writer feels may be in sympathy with the present trend of engineering thought in this matter—particularly so in Great Britain and in America. He feels that the hope so eloquently expressed by Mr. Pearce is capable of materialisation—that, in fact, great advances in foundry metallurgy rapidly approach realisation. The spirit of co-operation manifest in these International Congresses augurs that the moment of this realisation is not far distant. With the consideration and appreciation of additions to the knowledge made possible by investigators in all great industrial countries, it seems most proper and fitting to call attention to the brilliant advances, to the thoroughgoing work, of the able workers of Great Britain. From the very inception of the iron and steel industry, a very large portion of its phenomenal progress has been due to the efforts—individual and collective—of these men.

* A Paper read before the International Foundrymen's Congress on behalf of the A.F.A.

1 Proceedings of The Iron and Steel Institute, 1928.

2 The Magnetic and Electrical Properties of Cast Iron—Carnegie Scholarship Memoirs, 1928.

MR. J. W. BOLTON.

MR. JOHN W. BOLTON, who this year presented his Paper on "Some Interrelationships in Grey Iron Metallurgy" on behalf of the American Foundrymen's Association, was born in Terre Haute, Ind., in 1897, and received his technical training at Rose Polytechnic Institute, being graduated from this institution in 1908 with a degree of B.S. in Chemical Engineering. He later, in 1921, received an M.Sc. degree from Rose Polytechnic for advanced metallurgical work. Mr. Bolton has served as chemist and metallurgist with the Procter & Gamble Company, Niles-Bement-Pond Company, Black Clawson Company, and the Frank Foundries Corporation. At present he is chief chemist for the Lunkenheimer Company of Cincinnati. Mr. Bolton has contributed many Papers on original research in grey iron metallurgy before the A.F.A. and other associations and to the technical press. He is a member of important committees of the A.F.A. and A.S.T.M., and was the author of the A.F.A. exchange Paper before the 1925 meeting of the Belgian Foundrymen's Association. Mr. Bolton is well known for his painstaking researches and publications on the cupola, slags, microscopy of cast iron, phosphorus in grey iron, carbon forms in grey iron, mechanical properties of grey iron, etc.

Two Important Problems before Foundrymen.

Two problems before the foundryman to-day are: (1) Study of the influence of manufacturing practice on given grades of cast iron; and (2) Relationship of test results to engineering properties of the casting. A more detailed set of questions was proposed in a recent editorial in THE FOUNDRY TRADE JOURNAL as follows: "Ever since Mr. John Shaw presented his Paper to the summer meetings of the American Foundrymen's Association, the situation of theoretical consideration of cast iron has become more complicated. Arising from the discussions, the following questions have been posed: (1) Are experiments carried out on small quantities of synthetic mixtures of pure materials really helpful? (2) Are conclusions drawn from diagrams based on the summation of silicon and carbon contents of great value? (3) Is the control of the matrix of more importance than the control of the graphite formation? (4) Is the condition of the graphite dependent on the nature of the carbides resulting from composition or thermal history? (5) Can the recently discovered critical manganese percentage be definitely stated on theoretical grounds? (6) Can the low-carbon high-silicon development be related to one of the existing theories? (7) Can the super-heating theory be definitely substantiated? (8) Is the gas content of cast iron to be taken as a serious factor? (9) Is ingotism of paramount importance? (10) Are internal stresses receiving their quota of consideration in discussing some phenomena? (11) Can free graphite exist in normal cupola-melted iron? It is obvious that further Papers are needed which will clarify our ideas."

Four Factors Influence Mechanical and Physical Properties of Grey Cast Iron.

The properties, mechanical and physical, of any grey iron casting depend upon the following factors: (1) Chemical composition of metal, initial, incidental, and final; (2) structural,

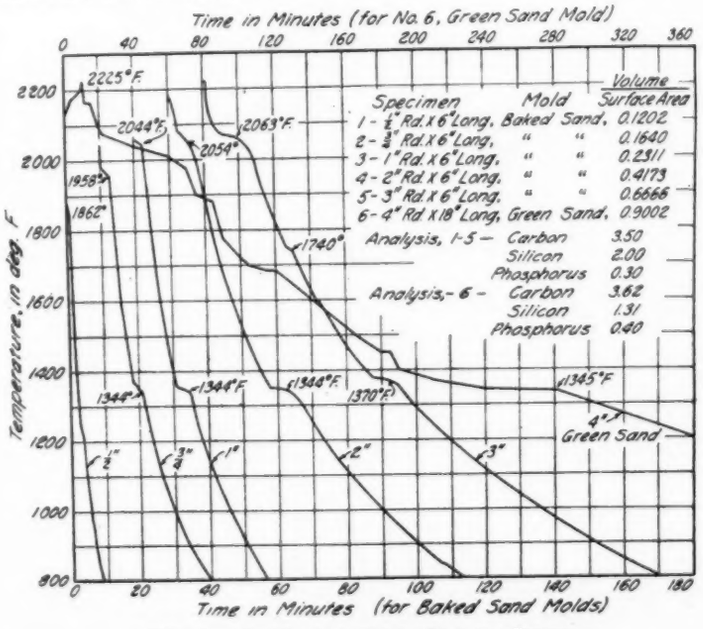


FIG. 1.—COOLING VELOCITY, COOLING CURVES.

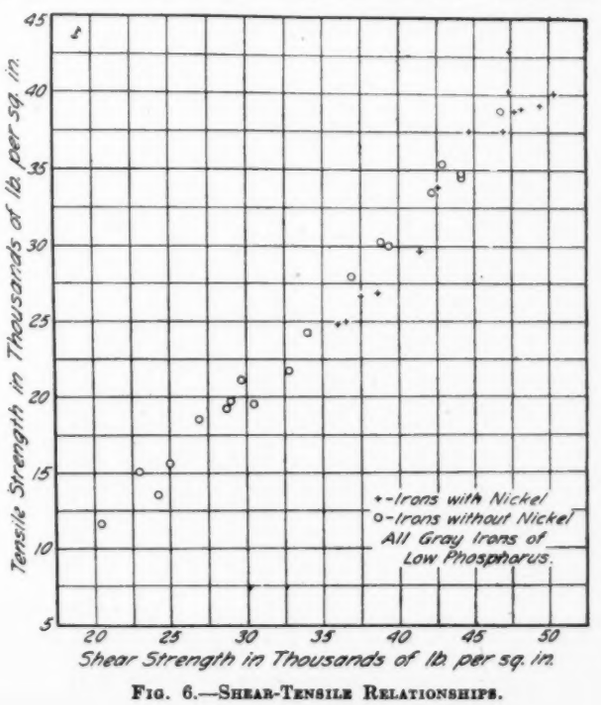

Tensile Strength in Thousands of lb. per sq. in.
Shear Strength in Thousands of lb. per sq. in.
+ - Irons with Nickel
o - Irons without Nickel
All Gray Irons of Low Phosphorus.

FIG. 6.—SHEAR-TENSILE RELATIONSHIPS.

mechanical and chemical make-up of charge (all materials); (3) melting process, conditions chemical, thermal and mechanical, and (4) thermal, chemical and mechanical history, furnace spout to finished casting.

The iron-carbon-silicon series of alloys known as grey iron contain pearlite, ferrite, and as cast formed graphite. Within this general structural make-up, alloys of widely divergent properties can be obtained. To attempt systematic study, it is necessary at first to classify or group these alloys. The simplest primary classification is according to chemical analysis of final alloy. Such a system of classification is outlined in Table I, based on percentages of total carbon and of silicon. Some 40 groups are listed. (It is obvious that some of these alloys are not grey irons unless cooled slower than at an ordinary cooling rate.) In addition certain sub-groupings are necessary according to presence of phosphorus, manganese, sulphur, various metals, metalloids, gases, etc. However, in usual foundry practice, the carbon-silicon groupings are most important.

Table I.—*Classification of Cast Irons according to Silicon and Carbon Content.*

Group No.	Carbon %.	Silicon %.	C + 0.30 Si.	C + Si.
1	Above 3.50	Above 2.50	4.25 up	6.00 up
2	" "	2.26—2.50	4.21 up	5.88 up A
3	" "	2.01—2.25	4.14 up A	5·63 up C
4	" "	1.76—2.00	4.06 up B	5.38 up E
5	" "	1.51—1.75	3.99 up C	5·13 up G
6	" "	1.26—1.50	3.91 up D	4.88 up I
7	" "	1.01—1.25	3.83 up E	4.63 up K
8	" "	0.76—1.00	3.76 up F	4.88 up M
9	3.26—3.50	Above 2.50	4.13 up A	5.88 up A
10	" "	2.26—2.50	4.09 B	5.76 B
11	" "	2.01—2.25	4.02 C	5.51 D
12	" "	1.76—2.00	3.94 D	5.26 F
13	" "	1.51—1.75	3.87 E	5.01 H
14	" "	1.26—1.50	3.79 F	4.76 J
15	" "	1.01—1.25	3.71 G	4.51 L
16	" "	0.76—1.00	3.64 H	4.26 N
17	3.01—3.25	Above 2.50	3.88 up D	5.63 up C
18	" "	2.26—2.50	3.84 E	5.51 D
19	" "	2.01—2.25	3.77 F	5.26 F
20	" "	1.76—2.00	3.69 G	5.01 H
21	" "	1.51—1.75	3.62 H	4.76 J
22	" "	1.26—1.50	3.54 I	4.51 L
23	" "	1.01—1.25	3.46 J	4.26 N
24	" "	0.76—1.00	3.39 K	4.01 O
25	2.76—3.00	Above 2.50	3.63 up H	5.38 E
26	" "	2.26—2.50	3.59 H	5.26 F
27	" "	2.01—2.25	3.52 I	5.01 H
28	" "	1.76—2.00	3.44 J	4.76 J
29	" "	1.51—1.75	3.37 K	4.51 L
30	" "	1.26—1.50	3.29 L	4.26 N
31	" "	1.01—1.25	3.21 M	4.01 O
32	" "	0.76—1.00	3.14 N	3.76 P
33	2.51—2.75	Above 2.50	3.38 up K	5.13 G
34	" "	2.26—2.50	3.34 K	5.01 H
35	" "	2.01—2.25	3.27 L	4.76 J
36	" "	1.76—2.00	3.19 M	4.51 L
37	" "	1.51—1.75	3.12 N	4.26 N
38	" "	1.26—1.50	3.04	4.01 O
39	" "	1.01—1.25	2.96	3.76 P
40	" "	0.76—1.00	2.89	3.51

Notes:—Manganese in most foundry irons runs between 0.45 and 0.80, within which range no sub-classification seems necessary. Phosphorus subdivisions might be 0.0—0.15, 0.16—0.30, 0.31—0.50, 0.51—0.70, 0.71—1.00; this element influences the stiffness of the metal, and also is a factor in its fluidity and hardness. At the present time, no logical subdivisions on sulphur content have occurred to the writer; perhaps the sulphur/manganese ratio will furnish a basis for further classification. Nickel and chromium have powerful influences on cast iron, and irons containing them exhibit somewhat different characteristics from "straight" silicon-carbon irons.

Table II.—*Computed Cooling Rates and Moduli.*

	Size of bar.	Length cast.	Length between supports.	Cross section area.	Surface area sq. in.	Volume cub. in.	Volume / Surface area.	Relative mod. rup.	Log. mod. rupture.
1	¼×12×12						0.1200		
2	0.500 d.	21	18	0.196	33.4	4.12	0 1234	366.640	2.56425
3	0.800 d.	15	12	0.503	38.7	7.55	0.1951	59.672	1·77577
4	0.875 d.	21	18	0.601	58.9	12.6	0.2139	68.414	1.83514
5	½×12×12	—	—	—	—	—	0.2308	—	—
6	1.00 d.	15	12	0.785	48.7	11.8	0.2423	30.552	1.48504
7	1.00 d.	21	18	0.785	67.5	16.5	0.2444	45.831	1.66116
8	1×1	27	24	1.00	110.0	27.0	0.2455	36.0	1.55630
9	1.20 d.	21	18	1.131	81.4	23.8	0.2924	26.523	1.42362
10	1.25 d.	15	12	1.227	61.4	18.4	0.2997	15.666	1.19496
11	1.30 d.	21	18	1.327	88.4	27.9	0.3156	20.860	1.31931
12	2×1	27	24	2.00	166.0	54.0	0.3253	18.0	1.25527
13	1×2	27	24	2.00	166.0	54.0	0.3253	9.0	0.95424
14	1.40 d.	21	18	1.539	95.4	32.3	0.3386	16.702	1.22277
15	1.50 d.	15	12	1.767	74.2	26.5	0.3571	9.052	0.95674
16	1.50 d.	21	18	1.767	102.5	37.1	0.3620	13.579	1.13287
17	1.5×1.5	27	24	2.25	166.5	60.75	0.3650	10.67	1.02816
18	1×12×12	—	—	—	—	—	0.4286	—	—
19	2.00 d.	15	12	3.142	100.5	47.1	0.4686	3.819	0.58195
20	2.00 d.	21	18	3.142	138.2	66.0	0.4776	5.7288	0.75806
21	2×2	27	24	4.00	224.0	108.0	0.4820	4.500	0.65321
22	2.20 d.	21	18	3.801	152.7	79.8	0.5226	4.3042	0.63389
23	2.50 d.	21	18	4.909	174.8	103.1	0.5898	2.9332	0.46734
24	2.5×2.5	27	24	6.25	282.5	168.75	0.5980	2.303	0.36229
25	3.00 d.	15	12	7.069	155.5	106.0	0.6817	1.1316	0.05369
26	3.00 d.	21	18	7.069	212.1	148.4	0.6996	1.697	0.22968
27	3×3	27	24	9.00	342.0	243.0	0.7110	1.333	0.12483
28	2×24×24	—	—	—	—	—	0.8571	—	—
29	4.00 d.	15	12	12.57	213.6	188.6	0.8830	0.477	9.67852–10
30	3×24×24	—	—	—	—	—	1.20	—	—
31	6.00 d.	15	12	28.27	339.3	424.1	1.250	0.141	9.14922–10
32	4×24×24	—	—	—	—	—	1.440	—	—
33	8.00 d.	15	12	50.27	477.5	754.1	1.579	0.0596	8.77525–10

Third, the cupola or furnace operation has much to do with the quality of metal melted therein. For example, it is known that superheating during the melting process at first tends to delay the progress of graphitisation on cooling. At still higher temperatures the effect of this phenomenon may be altered or changed. Iron badly oxidised in cupola-melting does not compare favourably with that obtained from a good hot working cupola with normal blast. Crucible-melted irons generally are not comparable with those obtained from the cupolas—a fact that has vitiated the exact practical significance of work of many investigators. Therefore, in any work on comparison or correlation, the exact type of furnace and its operating characteristics should be stated clearly.

Although the second factor—make-up of charge—undoubtedly is important, it seems impossible at the present time to attempt more than a qualitative classification. The degree of graphitisation of charged materials has some effect on the possibility of degree of solution of graphite during the melting process—hence on the presence of graphite nuclei in the molten metal. This, of course, influences the degree of graphitisation of the final casting. Thus the amounts of sand-cast pig, chilled pig, steel, scrap, etc., should be noted in all research work. Furthermore, the size of the pieces charged, their general grain-size, etc., should be indicated. Much careful research is needed to demonstrate whether or not the so-called inherent properties of the raw materials always persist unaltered through the melting process and influence the final product.[1]

Thermal and mechanical history of the metal from furnace spout to cooled casting is the fourth factor. The degree of graphitisation depends to a great degree on the cooling velocity from the liquidus to a temperature probably somewhat below the eutectoid point. The writer regards cooling velocity and composition the most important factors influencing the final properties of the metal. Cooling velocity is a curvilinear function, not easy to express in a simple manner, as shown in Fig. 1. It depends on many factors. Among these are:—(1) Initial temperature (which may or may not coincide with pouring temperature); (2) final temperature (*i.e.*, room temperature); (3) specific heat of the alloy, at all points along the curve; (4) volume of metal to be cooled; (5) metal-surface area, for dissipation of heat; (6) cooling gradients within metal and mould; (7) conductivity of mould material; (8) speed of pouring; (9) energy release apparent in thermal arrests (see Fig. 2); and (10) mechanical factors.

Relationship of Volume to Surface Area a Significant Factor.

It is apparent that with carefully-regulated foundry practice many of these factors are nearly constant, or at least susceptible to a reasonable degree of control. The most significant factor is the relationship of volume to surface area—expressing the well-known foundry fact that cooling rate is proportional to section size. In Table II is shown a list of various simple

[1] E. Piwowarsky, Trans. A.F.A., 1926, p. 914-981.

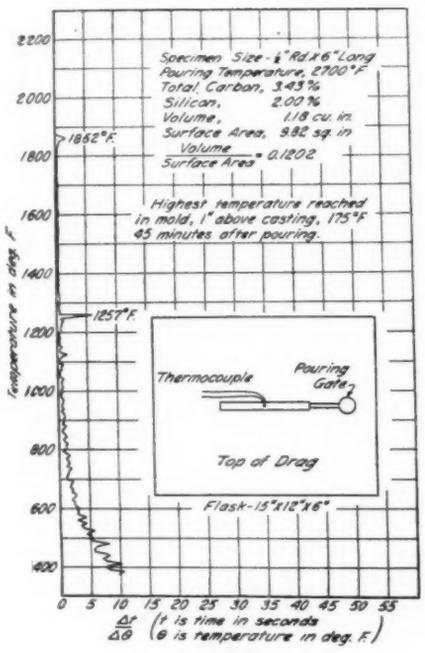

Specimen Size - ¼" Rd. x 6" Long
Pouring Temperature, 2700° F.
Total Carbon, 3.43%
Silicon, 2.00%
Volume, 1.18 cu. in.
Surface Area, 9.82 sq. in.
Volume / Surface Area = 0.1202
1862° F.
Highest temperature reached in mold, 1" above casting, 175° F. 45 minutes after pouring.
1257° F.
Thermocouple
Pouring Gate
Top of Drag
Flask - 15" x 12" x 6"
Temperature in deg. F.
Δt / Δθ (t is time in seconds, θ is temperature in deg. F.)

FIG. 2A.

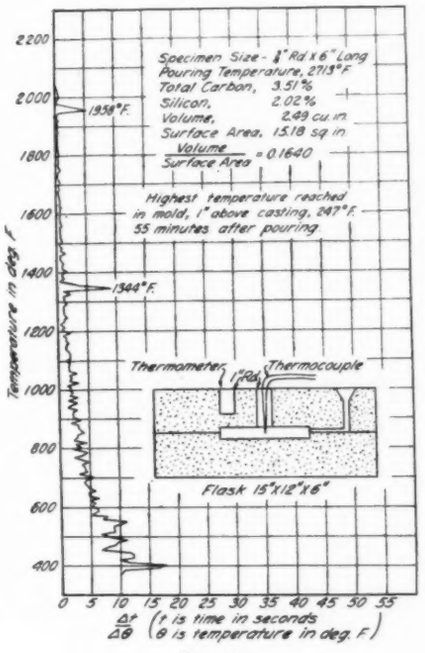

Specimen Size - ½" Rd. x 6" Long
Pouring Temperature, 2713° F.
Total Carbon, 3.51%
Silicon, 2.02%
Volume, 2.49 cu. in.
Surface Area, 15.18 sq. in.
Volume / Surface Area = 0.1640
1958° F.
Highest temperature reached in mold, 1" above casting, 247° F. 55 minutes after pouring.
1344° F.
Thermometer
½" Rd.
Thermocouple
Flask 15" x 12" x 6"
Temperature in deg. F.
Δt / Δθ (t is time in seconds, θ is temperature in deg. F.)

FIG. 2B.

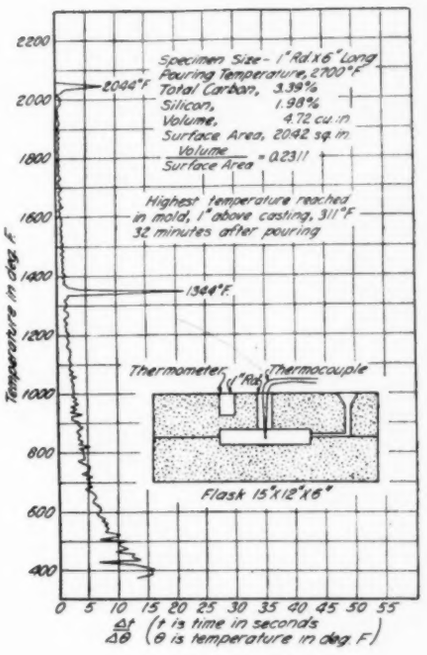

Specimen Size - 1" Rd. x 6" Long
Pouring Temperature, 2700° F.
Total Carbon, 3.39%
Silicon, 1.98%
Volume, 4.72 cu. in.
Surface Area, 20.42 sq. in.
Volume / Surface Area = 0.2311
2044° F.
Highest temperature reached in mold, 1" above casting, 311° F. 32 minutes after pouring
1344° F.
Thermometer
1" Rd.
Thermocouple
Flask 15" x 12" x 6"
Temperature in deg. F.
Δt / Δθ (t is time in seconds, θ is temperature in deg. F.)

FIG. 2C.

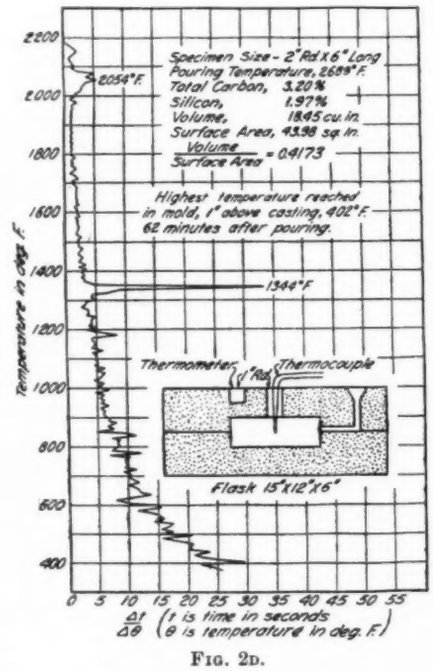

Specimen Size - 2" Rd. x 6" Long
Pouring Temperature, 2689° F.
Total Carbon, 3.20%
Silicon, 1.97%
Volume, 18.85 cu. in.
Surface Area, 43.98 sq. in.
Volume / Surface Area = 0.4173
2054° F.
Highest temperature reached in mold, 1" above casting, 402° F. 62 minutes after pouring.
1344° F.
Thermometer
1" Rd.
Thermocouple
Flask 15" x 12" x 6"
Temperature in deg. F.
Δt / Δθ (t is time in seconds, θ is temperature in deg. F.)

FIG. 2D.

FIGS. 2A TO 2E.—THERMAL ARRESTS.

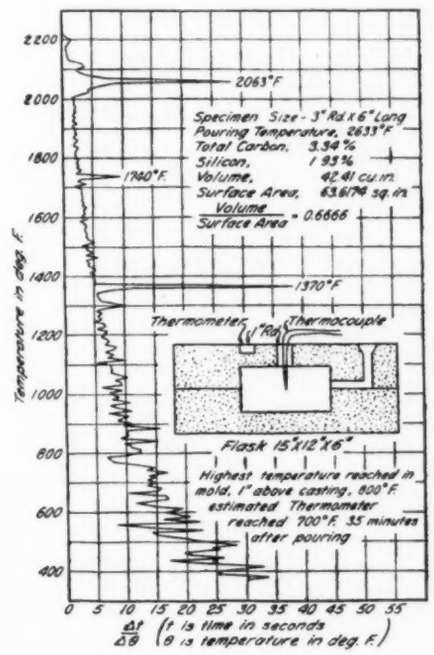

2063° F.
Specimen Size - 3" Rd. x 6" Long
Pouring Temperature, 2633° F.
Total Carbon, 3.34%
Silicon, 1.93%
Volume, 42.41 cu. in.
Surface Area, 63.6678 sq. in.
Volume / Surface Area = 0.6666
1740° F.
1370° F.
Thermometer
1" Rd.
Thermocouple
Flask 15" x 12" x 6"
Highest temperature reached in mold, 1" above casting, 600° F. estimated Thermometer reached 700° F. 35 minutes after pouring
Temperature in deg. F.
Δt / Δθ (t is time in seconds, θ is temperature in deg. F.)

FIG. 2E.

FIG. 3 (*below*).—RELATION OF $\frac{v}{a}$ TO ACTUAL COOLING RATE.

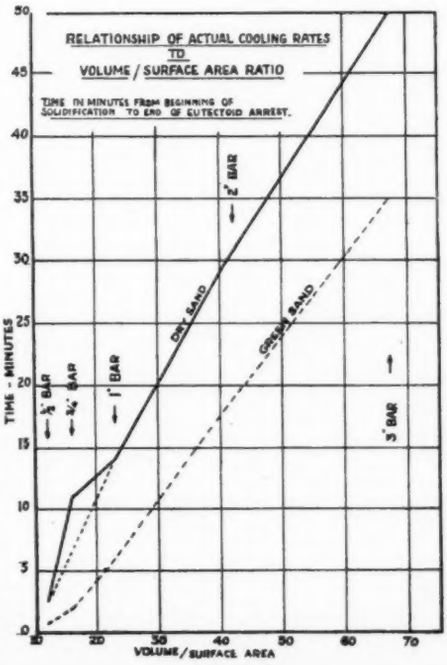

RELATIONSHIP OF ACTUAL COOLING RATES TO VOLUME / SURFACE AREA RATIO
TIME IN MINUTES FROM BEGINNING OF SOLIDIFICATION TO END OF EUTECTOID ARREST.
½" BAR
¾" BAR
1" BAR
2" BAR
3" BAR
DRY SAND
GREEN SAND
TIME - MINUTES
VOLUME / SURFACE AREA

FIG. 3.

shapes arranged in the order of their volume/surface area relationship.

In Fig. 3 there is experimental proof of the validity of this ratio for bars cast under carefully controlled and reproducible conditions. In this we have used the average rate of cooling from the solidification arrest (about 1,121 deg. C.) to the pearlitic inversion (about 732 deg. C.). (That there is some graphitisation below 732 deg. C. is well known.) It is interesting to contemplate the net effect to time-temperature (or cooling curves) *versus* temperature-graphitisation rates on the net rate of graphitisation under casting conditions.

The factors involved and their controllability follow:—(1) Initial temperature depends to some degree on the process employed and on the method of operation of the process; (2) pouring temperature is controllable; (3) final temperature may be assumed as constant; (4) specific heats of various types of iron do not vary much; (5) magnitude of cooling gradients within the metal itself are as yet little understood. That they are very important is evident from the variations in grain, size, etc., found on examination of the cross section of some castings—notably heavy sections with high-carbon irons. This effect is manifest in mechanical properties;[4] (6) conductivity of mould material, of course, varies somewhat. (See Fig. 3.) This is controllable for research purposes; (7) speed of pouring depends on gating and workmanship—both relatively controllable, but rarely defined in experimental work; (8) mechanical factors often are overlooked, as, for example, were the bars sand-cast, were they tumbled, what sort of risers were used, etc.?

[4] See Arthur Smith—"F.T.J." Feb. 2, 1928, p. 79, Fig. 2; also J. W. Bolton—Trans. A.F.A., 1928, Vol. 36, p. 499, Fig. 8.

Supplementary Data to Fig. 4.

Coefficient of Expansion (average 70–1,000 deg. F.):—

¼-in. test bar	.. ..	13.27 × 10^{-6} per deg. C.
½-in. test bar	.. ..	13.25 ,, ,, ,, ,,
1-in. turned to ¾-in.	..	12.49 ,, ,, ,, ,,
2-in. ,, ,,	..	13.39 ,, ,, ,, ,,
3-in. ,, ,,	..	13.27 ,, ,, ,, ,,

Growth (6 reversals, over 100 hours' test):—

¼-in. bar from 1.20 bar grows 8^{-5} in. per inch per hour at 750 deg. F.

¾-in. bar from 1.20 bar grows 0.589 per cent. in 100 hours at 1,000 deg. F.

125 times as fast at 750 deg. F.

Rockwell Uniformity—See Trans. A.F.A. 1928 (J. W. Bolton, p. 469–512):—

B 46 (centre)
39
38
58
59
67
66
65
59
60
59
69 (edge)

Drop Test—

Anvil 5 in. between supports. Hammer 20.*

Size.	Started at	Broke at	Times struck.
In.	In.-lbs.		
½	20	40	2
¾	40	70	4
1	50	120	8
2	200	1,100	30

* Note.—The 2-in. bar was struck 28 times, advancing by 20-lb. increments to 740 in.-lbs., then raised to 1,000 and broke at 1,100 in.-lbs.

Fatigue Limit:—

J. B. Kommers found the fatigue limit 11,800 lbs. on R. R. Moore machines.

Impact Value:—

J. B. Kommers, using a Russel impact machine, 12-in. span, found an impact value of 16.5 lbs. per cub. in., energy of rupture.

Discussion of Tensile Test Results from test bars from ordinary cupola practice.

In general, there is a very good agreement between all results, except that of Prof. Kommers on the ASTM arbitration bar. In case of the 1.0-in. size, Rother & Mazurie stated that they used a 0.875 tensile bar. No mention is made of special centring devices, and it would seem hard to get a 0.875 bar with threaded ends out of a 1.0-in. test-piece. Bolton used a 0.505 bar, which is fairly small. On the 1.20 and 1.25-in. bars, Bolton used a 0.686 bar, while Fletcher probably had a 0.800-in. bar, which should be slightly stronger, not quite so great a portion of the weaker centre. On both 2-in. and 3-in. bars Bolton used a smaller test-piece than Rother, which would explain a difference, as experienced in heavy sections. As shown by the writer ("Iron Age," Jan. 3, 1924) pouring temperature has more influence on the large bars. Along this line the following tests were made from a 2-in. bar.

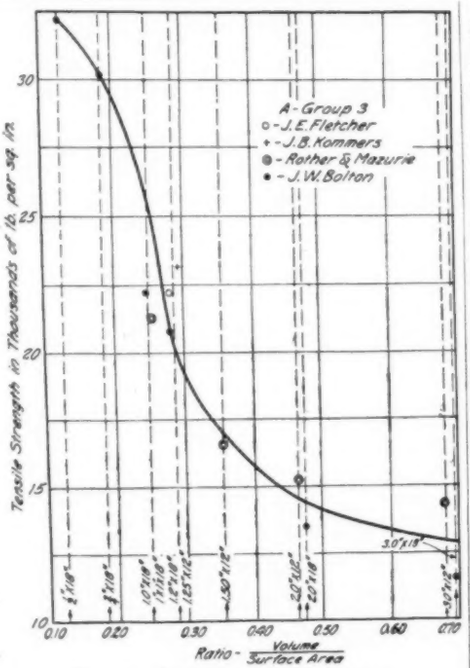


Fig. 4.—Study of Grade of Iron.

Dia. tested	Tensile.
1.38	14,021
0.800	13,485
0.505	12,875

Differences in moulding practice have much to do with the soundness of metal. In bronze, same pattern and pouring temperature, change to a smaller flask with larger gate made 3,000 lbs. average difference in tensile strength.

In any work of classifying irons according to mechanical test, the method of testing should be defined clearly and completely. In much research work neither analysis nor size of sections is mentioned.

Influence of Manufacturing Practice.

It, then, is possible to solve the first problem (study of the influence of manufacturing practice on given grades of cast iron) as follows:—

(A) Arrange a classification of irons according to composition: and (B) make an intensive study of each grade. In this study it is necessary to give consideration to the influence of the four factors indicated in a previous paragraph. Although there are vast gaps in the data necessary, methods of statistical research can be applied to very good advantage on existent data. A list of several interesting compilations of data is attached. A partial study of one grade of iron is shown in Fig. 4 and notes. The writer has compiled data covering many of the groups, and regrets that space is not available for inclusion of this voluminous, yet interesting, substantiation of the practicability of the scheme of study. These indicate that Mr. Pearce's hope is quite possible of practical realisation. While the very complexity of the problem denies exact mathematical prediction of each and every property, it is unquestionable that most of these will some day be charted to a degree of accuracy compatible with usual engineering practice. An exact analogy can be drawn to the art and science of the manufacture and testing of steel, wherein reasonably accurate engineering data can be found in many handbooks.

Relationship of Test Results.

The second problem is relationship of test results to the properties of castings. Two viewpoints predominate—that of many British and Americans, who believe that test results can be correlated so that properties of castings may be predicted therefrom with reasonable accuracy, and that of the French and other Continental investigators, who hold that tests must be made on the castings themselves. It is logical to expect that if a ladle of the same grade of iron is divided into two parts and each part subjected to exactly the same treatment, the two resultant materials will be the same. Very few Papers have been published in which definite attempts have been made to make test-piece and casting each comply with the four factors listed previously.

Reference serial.	Total carbon.	Silicon.	Combined carbon.	Manganese.	Sulphur.	Phosphorus.	Dia. cast.	Transverse load.	Deflection.	Span.	Transverse mod. rupture.	Tensile.	Tensile dia. pulled.	Shear.	Dia. sheared.	Brinell 3,000 kg.	Rockwell B.	Per cent. steel.	No. bars averaged.	Sp. gravity.
1	3.52	2.17	0.73	0.60	0.08	0.32	0.50	199	0.73	18	73,000	32,317	0.375	41,550	0.358	—	96	6	5	7.181
2	3.59	2.14	—	"Crane Pattern"			½ in. dia.	—	—	—	—	32,500	0.500	—	—	—	—	6	1	—
3	—	Max.	tests	½-in.	bars	—	—	203	—	—	—	33,760	0.375	—	—	—	—	6	—	—
4	3.52	2.17	—	0.60	0.08	0.32	0.75	566	0.49	18	60,830	30,243	0.505	38,800	0.505	180	90	6	6	7.112
5	—	Max.	tests	¾-in.	bars	—	—	600	—	—	—	30,534	0.505	—	—	—	—	6	—	—
6	3.52	2.17	—	0.60	0.08	0.32	1.00	1,191	0.275	18	51,290	22,205	0.505	32,850	0.505	162	88	6	4	7.116
7	—	Max.	test	1.0-in.	bar	—	—	1,275	—	—	—	22,725	0.505	—	—	—	—	—	—	—
8	3.52	2.10	—	0.60	0.10	0.34	1.06	1,917	—	12	53,900	21,250	0.875	—	—	—	—	0	3	—
10	3.54	2.20	0.56	0.64	0.07	0.27	1.20	1,922	0.276	18	50,900	22,125	0.686	—	—	154	85	6	12	7.094
11	3.52	2.14	0.48	0.49	0.12	0.63	1.20	—	—	18	47,500	22,450	?	—	—	—	—	—	2	—
12	3.68	2.17	0.55	0.54	0.08	0.65	1.25	3,450	0.123	12	54,000	23,200	0.33	—	—	172	87	0	5	—
13	3.68	2.17	0.55	0.54	0.08	0.55	1.25	—	—	12	—	24,900	0.60	—	—	—	—	0	5	—
14	3.52	2.10	—	0.60	0.10	0.34	1.03	2,450	—	12	40,400	square	—	—	—	—	—	0	3	—
15	3.52	2.10	—	0.60	0.10	0.34	1.55	7,725	—	12	37,200	square	—	—	—	—	—	0	3	—
16	3.52	2.10	—	0.60	0.10	0.34	1.57	5,975	—	12	46,600	16,500	0.875	—	—	—	—	0	3	—
17	3.53	2.09	0.58	0.52	0.05	0.84	2×1	2,085	0.34	24	37,500	—	—	rectangle	—	—	—	0	6	—
18	3.52	2.17	0.29	0.60	0.08	0.32	2.00	7,170	0.165	18	41,075	13,485	0.800	24,325	0.505	112	—	6	3	7.087
19	3.52	2.10	—	0.60	0.10	0.34	2.06	12,267	—	12	44,000	15,330	0.875	—	—	—	—	0	3	—
20	3.52	2.10	—	0.60	0.10	0.34	2.03	15,667	—	12	33,700	square	—	—	—	—	—	0	3	—
21	3.52	2.10	—	0.60	0.10	0.34	2.55	27,450	—	12	29,650	square	—	—	—	—	—	0	3	—
22	3.52	2.10	—	0.60	0.10	0.34	2.55	21,450	—	12	39,950	15,130	0.875	—	—	—	—	0	3	—
23	3.52	2.17	0.29	0.60	0.08	0.32	3.00	18,173	0.118	18	30,840	11,561	0.800	20,500	0.505	94	—	6	3	6.972
24	3.52	2.10	—	0.60	0.10	0.34	3.08	35,517	—	12	37,100	14,270	0.875	—	—	—	—	0	3	—
25	3.52	2.10	—	0.60	0.10	0.34	3.05	45,067	—	12	28,600	square	—	—	—	—	—	0	3	—

J. E. Fletcher—F.T.J., July 21, 1927—11. J. B. Kommers—Proc. A.S.T.M., 1923—12, 13. A. N. Talbot—17. W. Rother and V. Mazurie—Trans. A.F.A., 1926—8, 14, 15 19–22, 24, 25
J. W. Bolton—1-7, 18, 23.

That it can be done, may be demonstrated by one example and summaries of other tests—all very much condensed. The possibility of such correlation is so well recognised in America that leading specification-making bodies are proposing inclusion of such directions in specifications so that test and operating conditions may be as nearly as possible correlated.

group 27 or 28 of Table I. A detailed list of the test accompanies the diagram.

Tensile ..	T1	35,507 lbs.	T2 39,265	All these
Shear ..	1B	41,875 ,,	1C 45,946	tests
,, ..	2B	44,652 ,,	2C 45,650	from
			3C 46,418	casting.
Brinell, edge, average		203		
,, rib,		,, 195		

comparable to 39,265 lbs. per sq. in. of T2, taking T1 and T2 average value (37,368 lbs. per sq. in.) as representative of the casting, whose relative cooling-rate approximates that of a 2.4-in. bar, we take the value 37,800 per sq. in. from the writer's data. This is a good check when one considers that the tensiles T1 and T2 were taken from a section subject to some

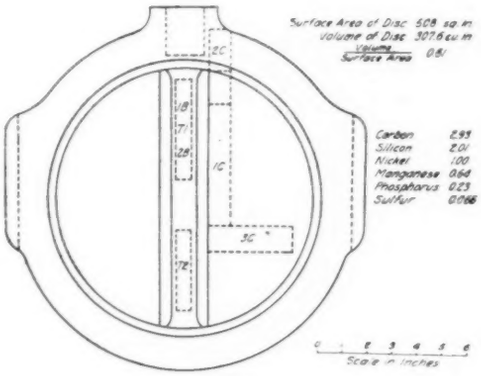


FIG. 5A.

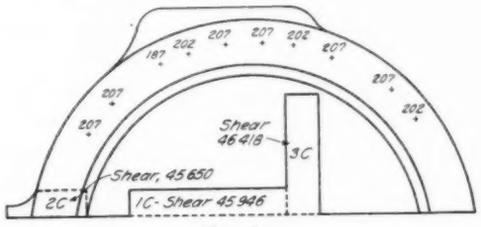


FIG. 5B.

FIGS. 5A TO 5C.—VALVE DISCS.

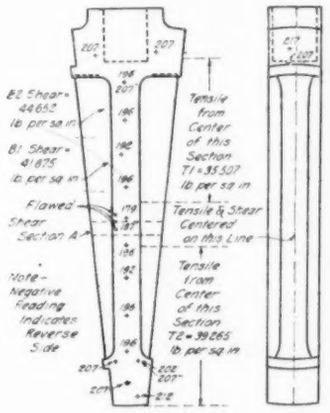

Tensile from Center of this Section T1=35507 lb per sq in
Flawed
Tensile & Shear Centered on this Line
Tensile from Center of this Section T2=39265 lb per sq in
Note - Negative Reading Indicates Reverse Side

FIG. 5C.

Example 1.—The casting of design shown in Fig. 5 was probed thoroughly. It was found that the volume/surface area relationship of this casting (overall) was 0.61, corresponding approximately with test bar 2.4 in. by 18 in. However, the casting is not uniform in section, and allowance should be made for this fact. This was a scrap casting, due to blowholes in portions indicated. The analysis shows carbon 2.93 and silicon 2.01 per cent. neither corresponding to

Tensile T2 is slightly higher than T1, the latter being in the heavier portion of the rib. Shears 1B and 2B are close to T1, their average 43,263 lbs. per sq. in. transferred to tensile in shear-tensile chart.[5]

The average of shear strengths 1, 2 and 3C, 46,005 lbs. per sq. in., corresponds to a tensile of about 38,000 lbs. per sq. in. (Fig. 6). This is

5 J. W. Bolton—Trans. A.F.A., 1928, p. 495, Fig. 4.

shrinkage. The Brinell numbers (195-203) when compared show that these compare with the tensile within the limitations of the Brinell correlation.

Following this same method of checking the actual strengths of castings with calculated strengths, we cite below six typical examples:—

Example 1 (above).—Actual tensile strength, 37,368; calculated tensile, 37,800.

Example 2.—125-lb. casting of uniform section. Actual shear, 31,345 lbs. per sq. in.; average, calculated, 31,525.

Example 3.—730-lb. casting, complicated shape, uniform section. Actual tensile strength, 28,433 lbs. per sq. in.; average, calculated tensile, 22,500. (*Note.*—Very small choke-gate was used, samples cut from far side.)

Example 4. — 700-lb. casting, sections 1 to 1½ in.; actual tensile, 28,843 lbs. per. sq. in., average, calculated tensile, 25,030.

Example 5.—325-lb. casting. Actual tensile, 27,055 lbs. per sq. in.; average, calculated tensile, 26,000.

Example 6.—300-lb. casting. Actual tensile, 22,250 lbs. per sq. in.; calculated tensile, 21,250.

All these examples were made on commercial castings, of reasonable complicated design, all but Example No. 1 were cored castings, and variations in section were those encountered in sound engineering practice. Although the results above obtained represent direct tests we have made, it is conceivable that greater variations may be found in practice. However, it is believed that greater variations usually will be explicable on comparison of the factors influencing the bars and castings under consideration.

Calculated data were obtained from test bars which, excepting Example No. 1, were *not* cast on the same day as the castings, but were from the same cupola and quite close to the same analysis. As in Example No. 1, tests using stress-strain diagrams, Brinell and shear were made. Some of the calculated data were interpolated from curves. From consideration of all these tests, the following opinions are justified.

Reasonable correlation of tests to the properties of the castings themselves must be established or cast-iron research is futile. It is the casting that the engineer designs, the manufacturer sells and the customer buys. These men care little about the "quality of the iron in the ladle." They are concerned only with what they get, namely, the casting. However, it is possible to tell a great deal about the

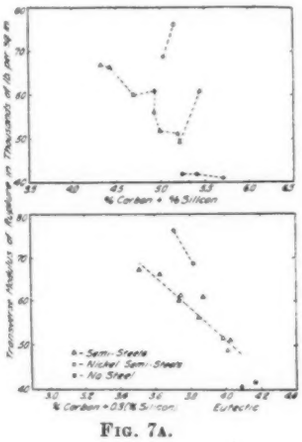


FIG. 7A.

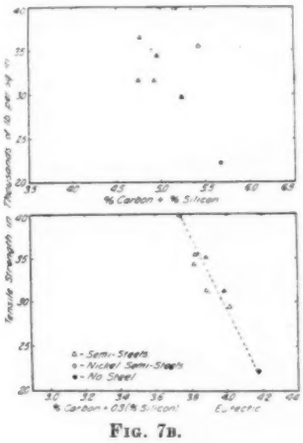


FIG. 7B.

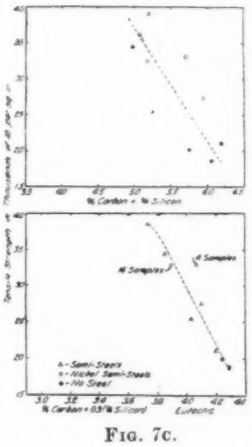


FIG. 7C.

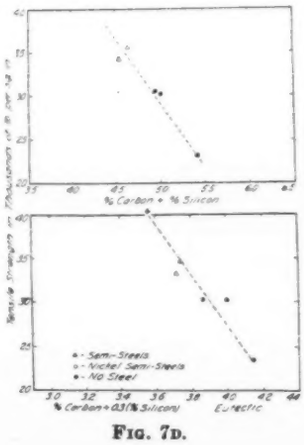


FIG. 7D.

FIGS. 7A TO 7E.—SILICON CARBON SUMMATIONS V.S. STRENGTH.

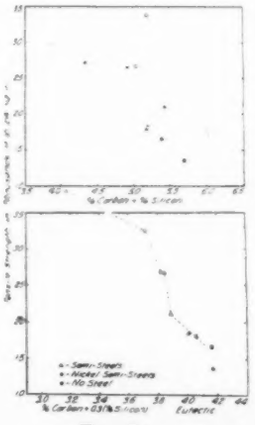


FIG. 7E.

quality of the metal in the casting, as is evident from the following considerations:—

(*a*) Many working properties of steel and other metals are predicted regularly from tests. Granting the limitations of the tests and the difficulty of their exact interpretation, which, by the way, applies to all materials, no one would deny that great progress has been made by use of tests. In a general way tests are used every day to determine properties of commercial metals.

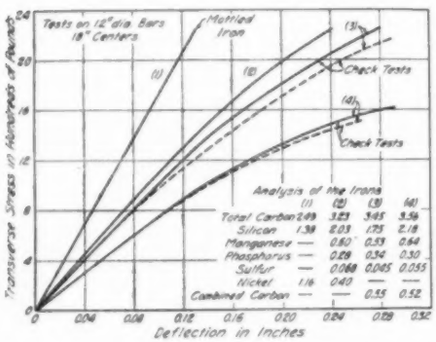


Fig. 8.—Comparison of Stress-Strain Curves of Various Irons.

(*b*) If in two or more cases exactly the same grade of material is accorded the same or equivalent treatment, the altered materials will still be the same, one to another.

(*c*) Test-bars are castings of certain specified shape and dimensions. If castings and test-bars all of the same analysis and cooling rate are poured at the same time from the same material, one would expect to find similar metal in each. The problems encountered are:—(1) to make

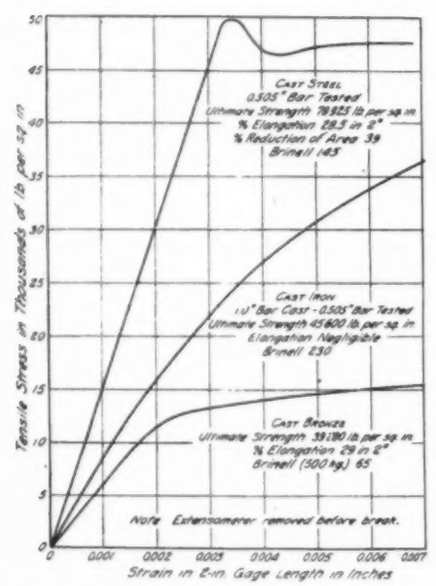

Cast Steel
0.505" Bar Tested
Cast Iron
1.0" Bar Cast - 0.505" Bar Tested
Cast Bronze
Note Extensometer removed before break.
Strain in 2-in. Gage Length in Inches

Fig. 9.—Stress-Strain Diagrams of Various Metals.

test-bars whose cooling rates are like those of the castings, and (2) to use common sense in making allowance for peculiarities in design and foundry practice—particularly those which may promote shrinkage or other defects and those which call for slow or fast pouring of castings.

(*d*) These points are borne out because the foundryman of wide experience can take an analysis and a result on one of the so-called arbitration test-bars and many times predict quite closely what the iron in the casting will be like.

It then is possible to solve the second problem —relationship of test results to the properties of the casting. What is needed is co-operation in accumulation and interpretation of sufficient data. Careful study must be made of test methods. In the correlation shown in the examples above, the general agreement becomes more remarkable when it is considered that (*a*) the metal flow in the castings may be slower than in the bar; (*b*) that the machined tensile bar is in case of the castings closer to the cooling surfaces than in the tensile bars—thus neglecting the well-known and demonstrated differences due to cooling gradients of unlike sections of similar volume/surface area relationship. This is most apparent in larger sections.

The usual commercial impracticability of the French scheme of trepanning a small shear sample from actual castings appears a barrier to the widespread use of this method. In America, attempts to get similar tests into specifications for steel castings have been opposed. There may be some merit in the idea of cast-on bars for certain types of casting. The work of the late George K. Elliott, Willard Rother, and the writer demonstrate certain objectionable features in the original Frémont test. This test, as proposed, was hardly precise enough for use in commercial specifications. The machine did not seem sufficiently rigid and the method of preparation of the test-bar by a hollow drill is open to criticism. Accurately-machined bars are an absolute necessity, and a rigid and accurate machine is needed. The test-piece proposed was too small to be representative of the general properties of the iron. On the other hand, the basic idea of the French engineers is very good. With proper modification, the shear test is quite useful in research work.

It perhaps is possible to indicate the American view point on several of the eleven questions asked by The Foundry Trade Journal.

Transactions of various American associations contain many discussions criticising attempts made to draw practical conclusions from crucible-melted metals. However, it is well recognised that general metallurgical understanding is enhanced by such work, and that it is of decided ultimate value.

No silicon-carbon summation results can be used as a short cut to complete knowledge of the expected properties of the metal. However, they are useful if applied with discretion. Some interesting relationships are implied in Figs. 7, 8, 9, 10 and 11. The same applies to attempts at correlation of Brinell values to tensile and transverse strength—useful within limits, but no panacea.

The present trend of thought seems to be that control of amount and form of graphite is more important than control of matrix alone. A 2.70 per cent. carbon iron of 0.60 per cent. combined carbon possesses different properties from a 3.70 per cent. carbon iron with 0.60 per cent. combined carbon. However, neither factor can be ignored. The condition of the graphite undoubtedly is dependent on the nature of the carbide resulting from influences of both composition and thermal history.

The work of the United States Bureau of Standards sheds a great deal of light on the lack of seriousness of the gas problem.[6] The importance of this factor seems to have been exaggerated unduly in former years.[7] We refer to dissolved gases, not to blowhole and incipient shrinkage.

Ingotism is very important, yet more recognised through inference than by direct reference. Macroscopic methods deserve more attention.

Internal stresses are being recognised in the heat-treating practices followed by many American firms.[8]

In presentation of this Paper, the writer has attempted to have it in sympathy with the present trend of American engineering and metallurgical thought. As one daily concerned in phases of practical operation in iron, steel and non-ferrous foundries, practical rather than

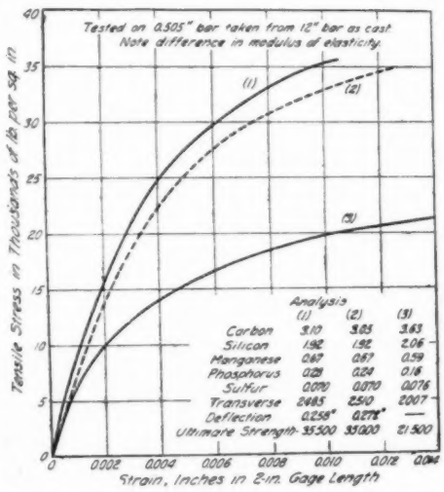

Tested on 0.505" bar taken from 12" bar as cast
Note difference in modulus of elasticity
Analysis
Strain, Inches in 2-in. Gage Length

Fig. 10.—Tensile Stress Strain of Various Grades of Cast Iron.

academic motives possibly are more apparent. On the other hand, it would be unfair to claim that all of the ideas herein advanced represent the unanimous opinion over here. In one matter the writer can voice a unanimous sentiment.

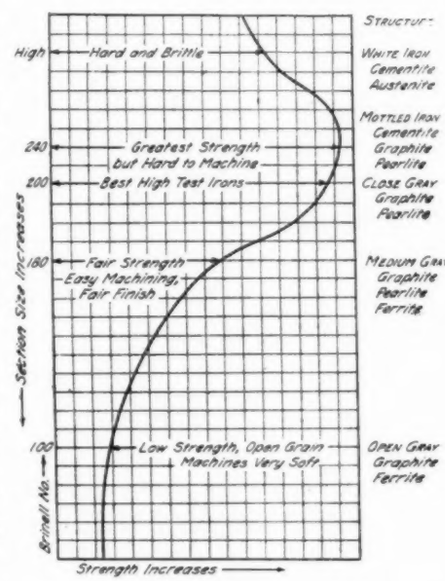


Fig. 11.—Qualitative Diagram of Section Tensile Relationships.

The American Foundrymen's Association, those whom it represents, have the greatest respect and cordiality for their fellow-workers across the sea. As the years go by they confidently hope and expect this feeling of good fellowship to continue and to expand to mutual advantage.

6 Jordan, Eckman & Jominy—The Oxygen Content of Coke and Charcoal Cast Iron. Trans. A.F.A. Vol. 33, pp. 431-441, 1925.
7 J. W. Bolton—The Foundry, Aug. 15, 1924, pp. 628-634.
8 O. W. Potter—Trans. A.F.A., Vol. 33, pp. 294-346, 1925

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Electric Arc Welding in Foundries.

Electric arc welding is now well established and its use is rapidly developing in all engineering and allied trades. The scope of electric welding in the foundry is very extensive, and, in fact, an electric arc-welding plant is an essential part of the equipment of a modern ferrous foundry. With every application of arc welding, the essential factor is a reliable weld, and as the knowledge of metallurgy of iron and steel has grown, so it has come to be realised that such welding depends on proved metallurgical and scientific principles.

Reliable welding can be obtained by the use of "Quasi-Arc" electrodes, as this electrode is based upon these principles, and it is due to the success which has resulted from its application that this process is now so largely employed in so many foundries.

In order to produce an efficient weld the following essential conditions must be observed:—(1) The heat put into the work during welding must be so limited that it will not overheat and produce brittleness in the metal of the work; (2) the mill scale, etc., on the surface of the work must be cleaned away efficiently by an acid slag so that perfect diffusion will be obtained between the weld and the metal of the work; (3) the atmospheric gases must be prevented from coming in contact with the molten metal, as otherwise defects will be formed which will render the joint brittle and peculiarly liable to corrosion; and (4) the weld metal should be deposited under such conditions as to render its structure homogeneous and of a fine crystal grain, whereby a reliable joint of a high value of mechanical strength will be produced. These conditions are obtained by use of the "Quasi-Arc" patent electrodes.

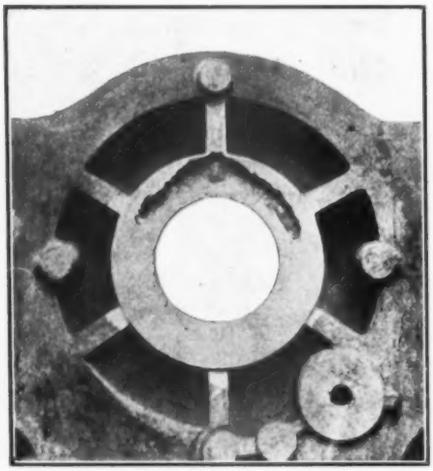

Fig. 1.—Defective Cylinder Casting.

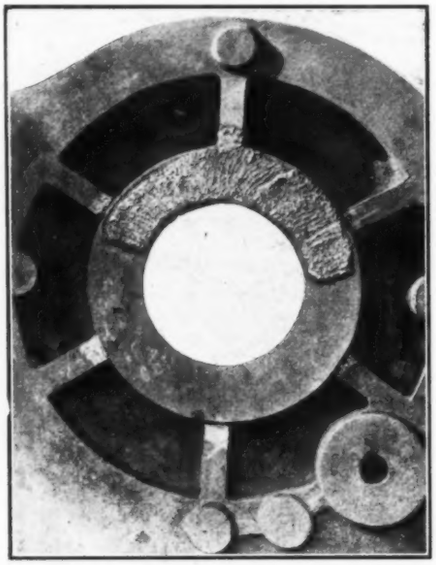

Fig. 2.—The Casting shown in Fig. 1 Made Good by Quasi-Arc Electrodes.

These electrodes are coated with a robust mineral flux having singular physical and chemical properties whereby a weld of the highest mechanical strength and purity is obtained. The flux melts in a continuous flow from the electrode to the work, enclosing the arc, and, by reason of its special composition, protecting the weld metal during deposition from attack by the atmospheric gases, thus enabling a pure and homogeneous metal to be deposited; it also protects the metal during cooling, so that a certain degree of annealing takes place. When cold the slag easily separates from the metal.

The flux, being acid in character, thoroughly cleans and removes all mill scale and dirt from the work. The "Quasi-Arc" electrode requires only a small current for fusion by reason of the low melting point of the flux, while its spiral application to the steel core ensures that the slag flows over the metal, thus making welding a simple operation and one which can quickly be acquired by a novice. The welding operation is both rapid and efficient.

In many processes of welding the work is overheated and rendered brittle by reason of the large amount of heat required for the operation, but owing to the small amount of heat required for fusion this objection is absent when the "Quasi-Arc" electrode is used, and consequently very little thermal disturbance occurs in the work. By reason of the purity of the "Quasi-Arc" weld metal it has a high resistance to corrosive agents. This is a very important matter, as rapid corrosion of a weld entails a short life and may lead to considerable loss and even dangerous results.

The principal use that the foundry has for electric arc welding is for the repair of castings which come from the mould showing small blowholes or imperfections on the surface, also in steel castings contractional pulls, and their presence would probably mean the scrapping of the casting. With the use of welding, all these imperfections and holes can be made equal to the casting, and by this means numerous castings which would be scrapped can be put into use. An example of this application is shown in Figs. 1 and 2, which illustrate a marine engine cylinder casting on which the rough machining opened up a cavity. This casting was afterwards made good by electric welding with "Quasi-Arc" electrodes.

The electric arc-welding process makes for large economy in any foundry, and the saving of castings quickly pays for the first cost of the plant. No doubt some engineers would think the cheapest means of filling the holes in the castings would be sufficient, but by using inferior electrodes it is probable that the added weld metal would be brittle and not properly fused to the parent metal, so that even in the machining or in its subsequent life the metal would come apart and either cause trouble or even mar the reputation of the foundry. It is, therefore, essential to use a reliable electrode which will make the weld as good as the remainder of the casting.

In the case of steel castings, the use of an electrode which can be used with low-current conditions is necessary, otherwise the steel will be overheated and burnt, and this will at least make difficult the machining of the faces of the castings. With a "Quasi-Arc" electrode, using, as it does, the minimum of amperage, the steel is not adversely affected. Apart from the use of electric arc welding in the recovery of castings, a welding plant proves of great value in making many repairs to worn or broken parts of machinery, etc., throughout the foundry.

The Quasi-Arc Company manufacture several types of electric welding plant, each of which is suitable for installation in foundries, but the selection of a plant is usually ruled by the power available and the number of welders it is intended to employ. The plant should also be capable of maintaining a stable arc at the lowest range of output, which should be in the neighbourhood of 25 ampères. This lower range is particularly necessary for small work and also the welding of cast iron, where the amount of heat put into the work when welding should be reduced to a minimum.

Newcastle Advertising Convention.

Industrial Press Section.

Under the auspices of the Trade and Technical Section of the Periodical Trade Press and Weekly Newspaper Proprietors' Association, the industrial press proprietors for the first time are taking part in the Advertising Convention, to be held at Newcastle-on-Tyne, June 15-19 next.

On Monday, June 17, the "Industrial Press" Session, over which Sir Edward Iliffe, C.B.E., M.P., is presiding, will be held in the Lower Ballroom, Assembly Rooms, at 3.0 p.m. The speakers at this Session will be Sir Gerald Chadwyck-Healey, Bart., C.B.E.; Mr. V. Watlington (Managing Director, English Electric Company, Limited, Chairman, British Electrical and Allied Manufacturers' Association); Mr. E. M. I. Buxton, and Mr. Percival Marshall (Chairman, P.T.B. and W.N.P.A.). The "Quest of Markets" is the theme of the Convention, and the speeches at this Session will provide manufacturers with points of interest to them in so far as they are concerned with the industrial press.

The New Parliament.

After four and a-half years of government under the Conservative Administration, the Labour Party has been put into office for the second time in the history of the nation. The recent General Election resulted in the return to Parliament of a large number of new Labour members, with a corresponding reduction in the strength of the Conservative Party. Many of the successful candidates are associated with the coal, iron and steel, engineering, and allied industries. Brief notices regarding these members are appended:—

Cheltenham.—Sir Walter Preston is a director of Messrs. J. Stone & Company, Limited, engineers and founders, of Deptford.

Fulham (East).—Col. Sir K. P. Vaughan-Morgan is a director and vice-chairman of the Morgan Crucible Company, Limited.

Heavy Industries Fair at Birmingham, 1930.—Arrangements for the forthcoming Heavy Section of the British Industries Fair in Birmingham are even more advanced than at the corresponding stage of organisation for the last Fair, for which the whole of the stand accommodation was booked seven months before the opening. It was reported at a meeting of the Birmingham Fair Council recently that more than 60 per cent. of the space has already been let, the requisite deposit of 25 per cent. having been paid in every instance.

Recommended Analysis for Gear Materials.—The proposed American recommended chemical composition for gear materials and blanks, sponsored by the American Gear Manufacturers' Association and the American Society of Mechanical Engineers, is as follows, for forged and rolled carbon steel:—Case-hardened (Class C) C, 0.15 to 0.25; Mn, 0.40 to 0.70. Untreated (Class N), C, 0.25 to 0.50; Mn, 0.50 to 0.80. Hardened or untreated (Class H) C, 0.40 to 0.50; Mn, 0.40 to 0.60. For all three classes: P, 0.045 max.; S, 0.055 max. per cent.

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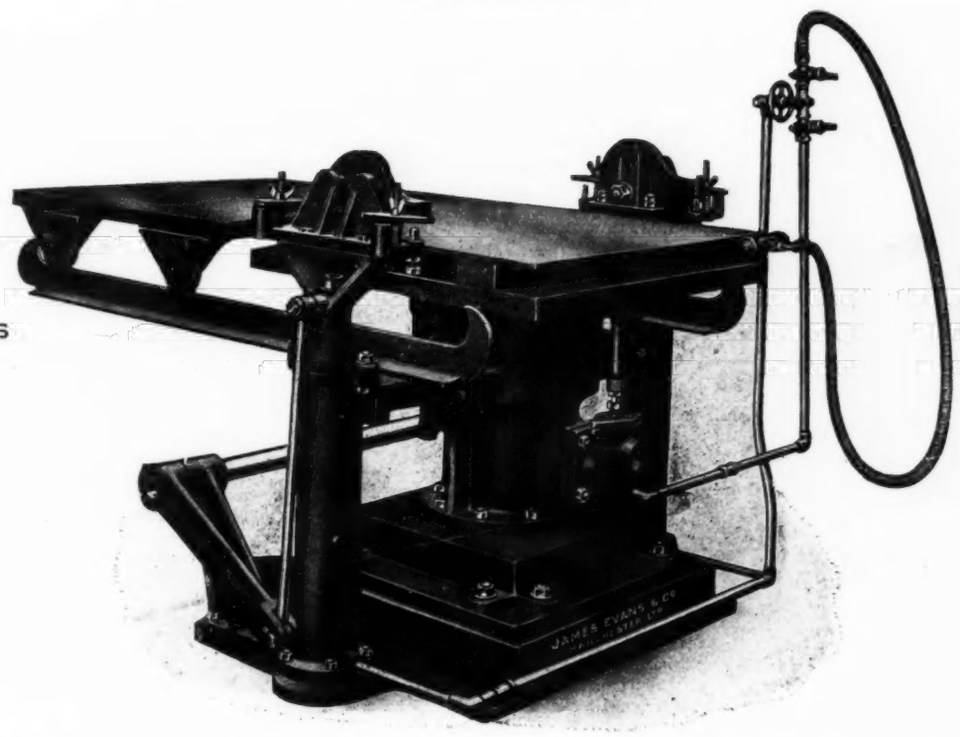

UNSKILLED LABOUR ONLY REQUIRED.

The above machine illustrates a Jar Ram Machine with Turnover Pattern Plate which can also be used for Stripping Plate Work.

The machine has been designed to combine the two distinct features above mentioned, and is practically two machines in one, equally suitable for steel, iron, etc.

The machine as illustrated is arranged for work that requires turning over, such as steel moulding. And while the turnover arrangements are intended for general repetition work, by detaching the turnover plate from the trunnion brackets the machine can be used for stripping plate work by attaching the stripping plate to the trunnion brackets. Or, on the other hand, by removing the trunnion brackets as well, the table can be used for jolting general jobbing work.

A very important feature of the machine is the simplicity with which the intensity of the Jolt can be regulated when the operator has become accustomed to the use of the machine, which takes but an hour or so. The valves all being on the exterior of the machine are easily accessible, and there is an adjustable arrangement that will allow the jolt to be varied between 1½ in. to below ¼ in. This being done without disturbing any part of the machine.

The machine is supplied with Withdrawal Carriage, Vibrator, and Blow-off Nozzle complete. It is substantially constructed to stand heavy wear and tear, and requires a minimum amount of skill to operate.

Another important feature of the machine is in the arrangement of the hard wood anvil block for receiving the shock. The blocks being carried well down the machine in a specially designed annular chamber give considerable relief to the foundations. It also provides against the possibility of fracturing the jolting table. Pitch pine blocks are also inserted between the foundation plate and the machine bedplate to assist in the relief on the foundations, and these features considerably improve the working advantages of the machine.

IT IS ALSO ENTIRELY OF BRITISH DESIGN AND MANUFACTURE.

JAMES EVANS & CO. (M/c) LTD.

Britannia Works, BLACKFRIARS, MANCHESTER.

Institute of British Foundrymen.

Annual General Meeting.

(*Continued from page* 440.)

had. He understood the complaint was that the men representing subscriber firms were not eligible to be officers of the Institute because they were not individual members of the Institute. He asked if Mr. Sutcliffe would take his assurance that the Council would go into the matter and discuss the position and try to put it on a proper footing.

Mr. Sutcliffe expressed his satisfaction with that assurance.

The President added that the matter would probably have to be dealt with at a meeting of the Council. Representatives of subscriber firms could not take office unless they were individual members of the Institute. That was quite clear, and that was the point that had to be cleared up. It was impossible for it to be dealt with that evening, but he quite realised that it was a matter that should be considered and cleared up. The position wanted defining more clearly than it was at present.

Mr. W. Jolley gave notice of motion that representatives of subscriber firms be allowed voting power.

The President suggested that that should be sent to the General Secretary.

Mr. Cook suggested that subscribing firms should nominate their representatives at the time of subscribing.

Mr. J. Longden said he had intended to raise this matter on behalf of the Scottish Branch because in canvassing recently for subscribing firms he had been told that the firm would not subscribe because it had no voting power, whereas if it paid the subscription of its foundry manager he would have a vote.

The matter was left for the Council to consider and decide upon a course of action.

The meeting then closed.

Acid Resisting Alloys.

NEW DEVELOPMENTS.

At a meeting of the American Institute of Mining and Metallurgical Engineers held in February at New York, a Paper on "Some New Developments in Acid-Resistant Alloys" was submitted by Mr. Burnham E. Field, who remarked that the work described was started several years ago because certain rather complex nickel alloys showed what was considered an unusual resistance to corrosion. This developed into a general investigation first of binary and then of ternary nickel alloys in an effort to find some that would be chemically resistant and also had physical properties qualifying them for commercial use. The nickel-molybdenum alloys having been discovered to possess resistance to hydrochloric acid, a fairly complete series of these alloys containing molybdenum up to the eutectic 49 per cent. was studied. While the alloys with more than 15 per cent. molybdenum were satisfactory from a corrosion standpoint, they had the disadvantage of being rather expensive, and further investigation was made to determine to what extent iron might be substituted to reduce their cost and improve their workability.

It had been believed (continued the author) that not over 10 per cent. of iron could be introduced without adversely affecting the acid resistance, but this investigation developed the interesting fact that maxima occurred in the corrosion curves at from 5 to 10 per cent. of iron. Beyond these maximum points the curves dipped again but with a second rise beyond 25 per cent. of iron. Experiments showed that an iron content as high as 20 per cent. with molybdenum also at 20 per cent. would resist corrosion. With more than 20 per cent. molybdenum it would not be possible to increase the iron appreciably and the cost would, therefore, rise out of proportion to the gain in corrosion resistance. With molybdenum above 20 per cent. the alloys become more rigid and more difficult to forge. The curves of the three most important factors, corrosion, cost, and workability, seemed to intersect at 20 per cent. molybdenum and 20 per cent. iron, with the remainder chiefly nickel.

Effect of Various Elements.

The effect of other elements has been studied, since it is not feasible to make an alloy absolutely free from impurities on a commercial scale. The effect of increasing carbon is to harden and toughen the alloy and at the same time decrease its resistance to acid. The best results are obtained with carbon not over 0.2 per cent. and it is not difficult to meet this specification commercially. Manganese, as in other nickel alloys, improve the workability, and until more than 3-per cent. manganese is added no detrimental effect on the acid resistance is noted. In such amounts silicon has little effect, but more than 0.5 per cent. affects the workability adversely. Vanadium in small quantities is valuable, and a small amount has been found to improve the acid resistance. Magnesium is useful in counteracting the detrimental effect of sulphur that may be present in the raw materials.

The nickel-molybdenum-iron alloy is resistant to cold acids, except nitric, showing as little as 0.000001 gramme lost per sq. cm. per hr., or 0.00003 in. penetration per month in 37 per cent. HCl at room temperature. Oxidising agents, such as chlorine, attack the alloy with considerable rapidity, and it is not recommended for use with chlorine unless the gas is dry. Solutions containing mixtures of acid and oxidising salts also attack the alloy more rapidly than acid alone. It stands up well in a salt spray, is practically unattacked by alkalies, and shows fair resistance to hydrogen sulphide in acid solutions, and to sulphurous acid.

Comparative Tests.

When tested in comparison with certain well-known commercial alloys in acids at 70 deg. C., the nickel-molybdenum-iron composition shows practically the same resistance towards 10 per cent. sulphuric acid as the best of these, while in 10 per cent. hydrochloric acid its resistance varies from 10 times that of the most resistant other alloy to 18 times that of another well-known composition. In general, it is easier to develop resistance towards sulphuric than towards hydrochloric acid, but the nickel-molybdenum-iron alloy appears about equally resistant to either acid at 10 per cent. strength and at 70 deg. C. Excellent castings can be made in sand. Welding with the oxy-acetylene torch presents no particular difficulty to an experienced welder, but the use of a flux is recommended to prevent oxidation, which would be detrimental to the acid resistance. Sections cut from experimental welds have shown practically the same resistance to hydrochloric acid as the unwelded sheet; this an unusual circumstance and is particularly advantageous for the manufacture of acid-resisting equipment.

Another acid-resisting alloy has been developed which shows some promise for commercial work; it is a nickel-base alloy but contains no molybdenum. Nickel-silicon alloys, with up to 10 per cent. of silicon, are fairly strong but not particularly acid resistant; at about 15 per cent. silicon they become resistant to acid, but very brittle. Approximately the same applies to nickel-aluminium alloys except that the zone of brittleness and resistance to acid is a little higher, being in the vicinity of 20 per cent. aluminium. Of the ternary nickel alloys in this group, the only one that combines useful strength with fairly good acid resistance is that containing approximately 10-per cent. silicon and 5-per cent. aluminium.

Value of Added Copper.

Studying the effect of adding copper to this nickel-silicon-aluminium alloy, it was found that from 2.5 to 3 per cent. copper gave a finer grained and considerably stronger alloy. Metallographic examination led to the idea that the sum of the silicon and aluminium should not exceed 12 per cent. if the formation of certain intermetallic compounds was to be avoided. The aluminium was diminished but the copper was retained, and favourable results followed at once. A nickel alloy containing approximately 10 per cent. silicon, 1.5 to 2 per cent. aluminium, and 3 per cent. copper makes strong, tough castings which are quite acid resistant. The alloy is not workable but is machinable with difficulty. Its Brinell hardness is about 364, and while this can be reduced to somewhat under 300 by heating for several hours at 1,050 deg. C. and quenching in water, it has not been found feasible to machine the alloy with anything but tungsten-carbide tools. These tools offer a means of performing simple machining operations, such as facing off a flange when grinding is not convenient.

The laboratory stage in the development of these alloys is largely complete, but laboratory corrosion tests cannot be considered as more than an indication of the value of an acid-resisting alloy. The ultimate criterion must be the test under plant conditions, and tests are being made by various chemical companies.

Impact Tests.

The difficult task of determining the stress-strain relationships in a specimen broken almost instantaneously in a Charpy impact machine has been attacked by R. Yamada, of the Japanese Research Institute for Iron, Steel and Other Metals. His experiments and conclusions are described in "Science Reports" of the Tohoku Imperial University.

He produced a narrow beam of light by a series of lenses and slits, and then interrupted this by a rapidly rotating disc with slots at the periphery. This interrupted beam made a series of lines on a photographic plate attached to the side of the swinging hammer (the equipment being mounted in a dark room). The distance between these lines gives the velocity of the hammer; from the change in velocity and the location of successive lines can be figured the energy absorbed by the specimen and the deformation. The total energy required to break a specimen, as figured in such a way, is within 3 per cent. of that found by the upward swing of the hammer.

Among other results, Yamada found that the energy absorbed by test-pieces of various sizes is proportional to the breadths only when the thickness is relatively very small; if the notch is the same depth and shape, the energy absorbed before fracture is more nearly proportional to the product of the breadth and the square of the effective thickness.

Toughness at Low Temperature.

Brittleness at temperatures down to −80 deg. C. was also investigated. Izod test-pieces, made of quenched and tempered steel with 0.1-per-cent. carbon, abruptly lost nearly all toughness at −30 deg. C. (either on slow or rapid test), the absorbed energy falling from 20 to 1 metre-kilogramme. A similar but less pronounced effect is noted between −20 and −40 deg. C. for 0.3-per-cent. carbon steel, quenched and tempered. A quenched and tempered nickel-chromium steel, and an annealed 0.5-per-cent. carbon steel (the latter unnotched) both showed a gradual decline of energy absorbed under impact fracture as the temperature decreased below zero, but the energy absorbed by slower loading is nearly constant down to −60 deg. C. Thus "brittleness" at low temperature is more pronounced in hard steels when tested in impact than under "static" testing.

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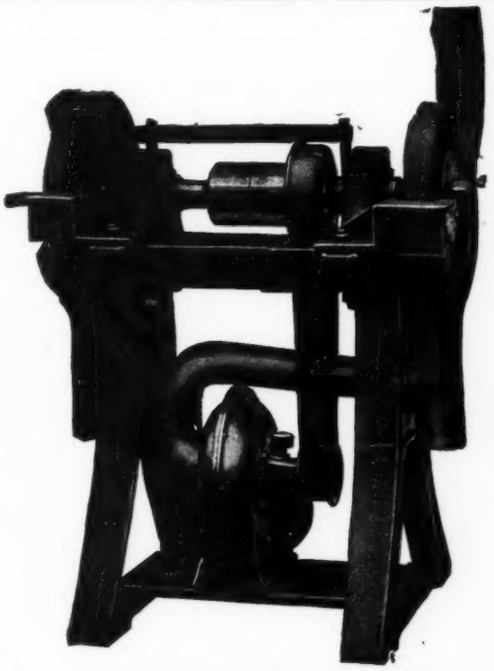

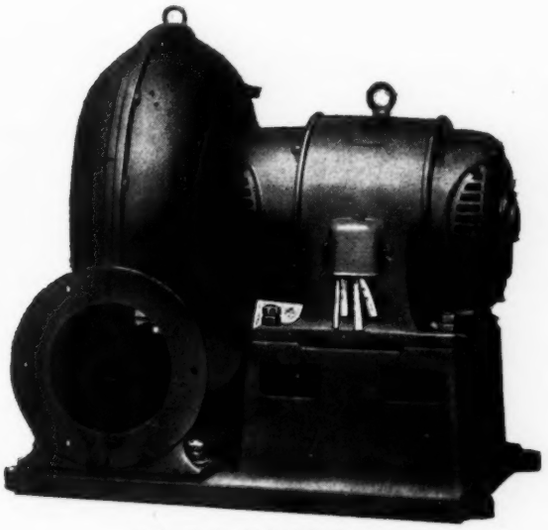

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Trade Talk.

Messrs. Simons & Company, Limited, Renfrew, have launched a bucket dredger.

Wailes Dove Bitumastic, Limited, have removed their head offices to larger premises at Collingwood Buildings, Newcastle-on-Tyne.

According to a report from Paris the Société Française des Aciéries Basset intends to erect new steelworks at Mortain, in Normandy.

An order for a new furnace has been placed by the United Steel Companies, Limited, with the Workington Bridge and Boiler Company, Limited.

Over 200 members of the Sheffield Technical Trades' Society visited the works of Messrs. Steel, Peech & Tozer, Limited, at Rotherham, last week.

The Millom and Askam Hematite Iron Company, Limited, announce that iron-ore shipments at Almeria from their Alquife Mines for the month of May totalled 35,485 tons.

It is expected that the Linthorpe-Dinsdale Smelting Company, Limited, Middlesbrough, will put two furnaces into blast before the end of the current month. They will make hematite.

Messrs. Earle's Shipbuilding and Engineering Company, Limited, have received an order from the Mersey Steamship Company, of Liverpool, for a vessel to be used in the coasting trade of Nova Scotia.

The London offices of Edgar Allen & Company, Limited, are to be transferred in the near future from 1, Victoria Street, S.W., to Artillery House, S.W.1. The new telephone numbers will be Victoria 4528 and 4529.

In conjunction with the Banque Credit Anversois, the Ougrée Marihaye Company, the Belgian concern, has formed a new company with a capital of 20,000,000 fcs. for the exploitation of an ironstone mine at Orada, Portugal.

The machinery supplied by Messrs. W. H. Allen, Sons & Company, Limited, of Bedford, for the new main drainage system of Cairo, which was opened by the King of Egypt on April 25, has satisfactorily answered all the tests applied to it.

Messrs. W. E. Hinde & Company, of Cardiff, have placed an order for a second new steamer of about 7,600 tons with Messrs. Craig, Taylor & Company, Limited, Stockton-on-Tees. The engines will be constructed by Messrs. Blair & Company (1926), Limited.

It is reported that the Anglo-American Steel Company, Limited, is acquiring works near Sheffield, and it is expected that in the near future they will be manufacturing "Carsil" ore process steel for all purposes. There is a Greaves-Etchell electric furnace installed in the works to be acquired.

The Associated Blacksmiths, whose headquarters are at Glasgow, state that returns from the branches indicate a considerable improvement in trade. Almost 300 unemployed members have obtained work since the last report was issued. The principal improvement is in shipbuilding and engineering establishments.

The British Consul-General at Bogota has forwarded a copy of a standard specification recently issued by the Colombian Ministry of Public Works in connection with metal structures for bridges. British firms can obtain a copy of the specification from the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

Messrs. James A. Silver, Limited, Roseneath, recently launched the twin-screw motor-yacht "Morag," which they have built for Commander Kitson, R.N. The vessel, which has a distinct naval appearance, has a speed considerably greater than the usual motor-yacht of the size, is fitted with two Kelvin sleeve-valve type engines.

Messrs. Alexander Stephen & Sons, Limited, Linthouse, Glasgow, have launched the single-deck cargo steamer "Masunda," of 5,000 tons gross, which they built for Messrs. Maclay & M'Intyre, Limited, Glasgow, for their general cargo trade. The machinery, consisting of triple-expansion reciprocating engines, is being supplied by the builders.

It is stated that the United Steel Companies, Limited, propose putting down new plant at Workington for the manufacture of cement from blast-furnace slag. The average production of slag at the company's ironworks at Workington is between 4,000 and 5,000 tons per week, and samples recently submitted to analysis have been found to be satisfactory for cement-making purposes. A site in close proximity to the Workington dock has already been chosen.

Messrs. Harland & Wolff, Limited, launched the twin-screw steamer "Lochness" for the Stornaway mail, passenger and cargo service. The vessel is 208 ft. in length, 38 ft. broad, and has a speed of 14 knots. This is one of the two vessels ordered in January and March of this year by Messrs. David MacBrayne (1929), Limited, under their agreement with the Post Office. It is stated that the orders for the remaining three of the five vessels have now been placed. The second vessel was ordered from Messrs. Henry Robb, Limited, Leith, for service between Oban, Fort William, Kinlochleven, the Sound of Mull and Loch Stuart, and is expected to be ready shortly.

Overseas delegates to the International Conference organised by the Institute of British Foundrymen visited the Trafford Park works of the Metropolitan-Vickers Electrical Company, Limited. Naturally, the foundry and pattern-shop buildings were the subject of particular interest. The main foundry building is 778 ft. long, 300 ft. wide and 63 ft. high. The products of the foundry include castings both of iron and non-ferrous metals, ranging up to 70 tons in weight. Several large castings were poured during the course of the visit. The foundry and pattern-shop together employ over 1,000 workpeople and produce over 1,000 tons of finished castings per month, the whole of the output being used in the company's own manufacture.

A large extension to the works of Messrs. Glenfield & Kennedy, Kilmarnock, has just been completed, consisting of a heavy engineering shop. A distinguished company of civil, water and municipal engineers was present at a formal ceremony, when the new portion was declared open. Sir Alexander Walker, K.B.E., one of the directors, in the unavoidable absence of Mr. James A. Morris, the chairman of the company, pressed an electric button which set a 26-ft. dia. turning and boring mill in motion. The cost of the extension was £60,000. The visitors made an inspection of the works, and were afterwards entertained to luncheon. Considerable alterations in the foundry department, including mechanical charging for the cupolas, are in progress.

Messrs. A. Hall & Company, Limited, Aberdeen, recently launched a large twin-screw bucket hopper dredger—the first of its kind to be built in Scotland—for the James Dredging and Towage Company, Limited, London and Southampton. The vessel, which was named "Foremost," is part of a big programme of dredger construction which Messrs. Hall & Company have been carrying out for the firm during the past two years. At the launching ceremony Mr. D. M'Intosh, manager for the builders, said the building of dredgers such as the "Foremost" represented an entirely new departure for them. For a long time the Clyde had held the monopoly in that class of work, and it was a tribute to the progressive policy of A. Hall & Company, Limited, that they had succeeded in breaking that monopoly.

Obituary.

Mr. Thomas M'Feat, of Messrs. R. & A. Main, Limited, Falkirk, died recently at his residence in Camelon.

Mr. William Hamilton Kidston, chairman of Messrs. A. G. Kidston & Company, Limited, iron and steel merchants and exporters, of Glasgow and London, died at Falmouth on Tuesday, June 4, aged 77.

Professor P. Gillespie, whose death is announced in a message from Toronto, had been Professor of Applied Mechanics in the University of Toronto since 1920. He was a member of the main committee of the Canadian Engineering Standards Association.

The death has occurred, in Derby, of Mr. Walter Johnson Frost, one of the best-known men in foundry and engineering circles in the Midlands. The deceased was the managing director of Frost Bros. (Derby), Limited, refrigerator manufacturers. His firm has fitted two refrigerators at Sandringham for the King.

Mr. Arthur Richards, J.P., of Wednesbury, has died at the age of 66. He was a son of the late Mr. Charles Richards, who founded the firm of Charles Richards & Sons, Limited, nut and bolt manufacturers, of Imperial Works, Darlaston. Mr. Richards was also a director of the Midland Bolt, Nut and Rivet Company, Limited, Darlaston, Criterion Stampings, Limited, Willenhall, and the Newport Rivet Company, Limited.

Personal.

Mr. A. Campion, F.I.C., informs us that he has removed to 8, Thorn Road West, Bearsden, Glasgow.

Mr. Gerald D. Flather, a director of Messrs. W. T. Flather, Limited, Standard Steelworks, Sheffield, was the recipient of a presentation from the employees of the firm at a gathering in celebration of his silver wedding.

Wills.

Armitage, Edward, of Tilford, Surrey, a director of the Farnley Iron Company, Limited £153,078

Brook, Tom, of Huddersfield, founder of Messrs. T. Brook & Sons, Limited, engineers £8,615

Dickinson, W., of Healey Mount, Burnley, Lancs, and head of Butterworth & Dickinson, Limited, Globe Ironworks, Rosegrove, Burnley, iron, steel and brassfounders £138,712

Bashford, Andrew, of Sheffield, mechanical engineer, connected with Messrs. Brown Bayley's Steel Works, Limited, and the Sheffield Steel Products Company, Limited £1,449

Reports and Dividends.

Pease & Partners, Limited.—Loss, £100,286; interest on debenture stock and on sinking fund, loan, etc., £86,324; depreciation, £36,005; debit balance brought in, £838,018; total debit, £1,060,634.

Consett Iron Company, Limited.—The directors propose to pay one year's arrears of dividend on the preference shares at 8 per cent. per annum, less tax. They are unable to recommend a dividend on the ordinary shares for 1928-29.

Whitehead Iron and Steel Company, Limited.—Net profit, after placing £15,000 to depreciation reserve, of £41,108; brought in, £4,659; final dividend of 5 per cent., making 10 per cent., less tax, for the year; to general reserve, £10,000; carried forward, £10,241.

Callender's Cable and Construction Company, Limited.—Net profit, £360,580; brought in, £474,165; depreciation, £50,000; provision for income-tax, £10,000; interest on debenture stock, £13,500; dividend on 6½ per cent. preference shares, £26,000; dividend on 7½ per cent. preference shares, £30,000; stamp duty on new capital, £5,000; to pension fund, £10,000; carried forward, £570,246.

Contracts Open.

London, S.E., June 18.—650 tons of caissons and well curbs, for the India Store Department, Belvedere Road, Lambeth, London, S.E.1. (Fee 5s., non-returnable.)

London, S.E., June 21.—300 steel axles for carriages and wagons, for the India Store Department, Belvedere Road, Lambeth, London, S.E.1. (Fee 5s., non-returnable.)

London, S.W., July 1.—Structural steelwork, bolts and nuts, and galvanised cast-iron piping, for the Madras and Southern Mahratta Railway Company, Limited, 25, Buckingham Palace Road, Westminster, S.W.1. (Fee £1 1s., non-returnable.)

Melbourne, August 19. — Three coal-weighing machines, for the State Electricity Commission of Victoria. The Department of Overseas Trade. (Reference A.X. 7,997.)

Montevideo, July 17.—Three travelling cranes and accessories, for the State Electricity Works of Montevideo. The Department of Overseas Trade. (Reference A.X. 8,036.)

Simla, India, July 16.—Sluice gates (vertical, sliding and radial types), for the Indian Stores Department, Simla. The Department of Overseas Trade. (Reference A.X. 8,013.)

Uruguay, July 22.—300-kilo. electro-pneumatic drop-hammer, for the Montevideo Port Authorities. The Department of Overseas Trade. (Reference A.X. 7,974.)

F.T.J. 13 6 29.

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—In summarising the present position of the Cleveland iron trade, current reports do not, unfortunately, suggest an early solution of existing difficulties, previously reviewed in these columns, which, if anything, appear to be on a cumulative scale as far as concerns more ample supplies of foundry pig-iron to meet the growing demand alike in the home and export markets. In this connection only partial relief is afforded from outside sources, the Midland furnaces being also well sold, and it is therefore probable that consumers of this quality of iron will, for some time, have to wait until costs of production can be substantially reduced before their needs can be fully satisfied. How long it may be before the ironmasters will be prepared to take fresh orders it is impossible to say—possibly it may be months hence, but whenever new sales are effected consumers may count on an advance in price. Nominally No. 1 Cleveland foundry iron is now at 75s., No. 4 foundry 71s. 6d., and No. 4 forge 71s. per ton.

In contrast with the situation above outlined with regard to foundry pig, there is, as yet, no acute shortage of supplies of East-Coast hematite, though it would be difficult to buy for June delivery, but for July, August and September makers are still selling on the basis of 74s. per ton for mixed numbers and 74s. 6d. for No. 1 quality. At these figures there is an active export trade in addition to substantial home sales, buyers being clearly convinced that prices will advance. On the North-West Coast also demand is brisk, with Bessemer mixed numbers now quoted 1s. per ton higher at 75s. at works for prompt delivery.

LANCASHIRE.—A steady and progressive demand is now reported in markets for pig-iron in this area, with the new scale of revised prices fairly well maintained, as follow :—Derbyshire No. 3, 72s., with Staffordshire at 73s. and Scottish brands at about 91s., all per ton, delivered Manchester and equal.

THE MIDLANDS.—Although the demand for pig-iron in this area is still much below a satisfactory average, the market generally is hopeful of an early revival, and prices remain steady, current quotations now ruling as follow :—Derbyshire No. 3, 73s. 6d.; North Staffordshire No. 3, 74s. 6d.; Northamptonshire No. 3, 70s., delivered Birmingham and Black Country stations.

SCOTLAND.—Both demand and fresh inquiries for Scottish foundry iron continue on a limited scale, and makers, merchants and consumers alike complain of the prevailing conditions. There was a meeting of the pig-iron makers last week, when the question of an advance in price was considered. It was decided to raise the official minimum prices for foundry and forge pig-iron by 2s. per ton and basic by 1s. per ton. No. 3 foundry iron, therefore, now stands at 74s. 6d.

Finished Iron.

At Birmingham this week no fresh developments in connection with the manufacturing departments were noted, and, though the demand for marked bars keeps up to a fairly good level, producers are anything but satisfied with the position. Of late there has been some decrease in the demand for crown bars, and none of the mills has sufficient business in view to maintain regular working. Marked bars are quoted at £12 at works. The prices of crown iron continue to vary to a considerable extent, and are quoted at from £9 10s. to £10. These figures are fixed by the local makers, who still experience competition from Derbyshire and Lancashire. With regard to the cheap grade of iron for nut-and-bolt work, most of the business now offering from the Darlaston area is being placed with the Continental mills, the local product being offered at £9 to £9 5s., while the foreign material can be obtained at £7 2s. 6d. to £7 5s.

Steel.

At Sheffield the demand for basic billets continues the chief feature in the steel market. Acid billet demands are small, with prices unchanged. Foreign producers are now making no offers of substantial tonnages of semis in the British markets. They are booking orders for extended delivery, but anything like early delivery is out of the question. At present most departments of the steel trades have covered their requirements for the time being, and at the moment the demand is rather quiet. On the other hand, the steelworks booked a considerable amount of business prior to the advance in prices at Whitsun, and most of them are not too badly off for work. In the tinplate market most of the makers appear inclined to hold to their quotations, which range round 18s. 3d. basis for coke finish, net cash, f.o.b. Wales.

Scrap.

Business in most markets for foundry scrap metals during the week has been distinctly quiet, with few changes of note in prices, which remain generally firm. On Tees-side the foundries are still paying 65s. for good ordinary heavy cast iron delivered, and for machinery quality 67s. 6d. is quoted. In the Midlands the majority of the foundries are fairly busy, and dealers have no difficulty in disposing of the whole of their available supplies. Heavy cast-iron scrap is quoted at 72s. 6d., and light cast-iron scrap at 60s. delivered. In Scotland demand is slack, with heavy machinery cast-iron quality at around 72s. 6d. and cast-iron railway chairs at 67s. 6d. to 68s. 6d., all delivered works.

Metals.

Copper.—Markets for base metals generally of late have developed an apathetic tendency on the part of buying interests, but towards last week's close a rather more active movement was observable, and prices evidenced some signs of recovery from the lower levels previously recorded. At the moment, producers in the United States are very confident as to their ability to maintain the selling price at its present rate, and hopes of the increasing production forcing values lower is rendered less likely by the news that the Phelps Dodge Company have actually had a curtailment programme in force since May 1.

Closing quotations are :—

Cash.—Thursday, £74 6s. 3d. to £74 8s. 9d.; Friday, £75 to £75 2s. 6d.; Monday, £75 15s. to £75 17s. 6d.; Tuesday, £76 7s. 6d. to £76 10s.; Wednesday, £74 12s. 6d. to £74 15s.

Three Months.—Thursday, £74 to £74 2s. 6d.; Friday, £74 11s. 3d. to £74 13s. 9d.; Monday, £75 2s. 6d. to £75 15s.; Tuesday, £75 7s. 6d. to £75 10s.; Wednesday, £74 to £74 2s. 6d.

Tin.—Fluctuations in standard tin of late have been irregular, but usually confined within narrow limits, subject mostly to support from the group. The statistical position reveals no very startling changes, the total visible supply, 24,765 tons, having been near to anticipated figures, and creating little surprise in the market. In the meantime the future of the market still continues to depend upon the ability of the group to provide support.

Official closing prices :—

Cash.—Thursday, £198 to £198 2s. 6d.; Friday, £199 15s. to £199 17s. 6d.; Monday, £200 7s. 6d. to £200 10s.; Tuesday, £202 5s. to £202 7s. 6d.; Wednesday, £200 12s. 6d. to £200 15s.

Three Months.—Thursday, £201 2s. 6d. to £201 5s.; Friday, £202 12s. 6d. to £202 15s.; Monday, £203 7s. 6d. to £203 10s.; Tuesday, £205 5s. to £205 7s. 6d.; Wednesday, £203 15s. to £203 17s. 6d.

Spelter.—This section of the market is at present experiencing a dull period, but the opinion is widely held that consumers are none too well covered for any distance ahead, and at the moment are limiting their buying to a level which does not provoke price increases. With regard to the European situation, there can be no doubt that consumption is definitely in excess of production, and that, with the present reserve, the margin is insufficient to prevent a shortage should any sudden or large improvement in the demand arise.

Daily quotations are :—

Ordinary. — Thursday, £26 5s.; Friday, £26 8s. 9d.; Monday, £26 7s. 6d.; Tuesday, £26 6s. 3d.; Wednesday, £26 3s. 9d.

Lead.—Business in soft foreign pig continues quiet, and, on the whole, consumers are still remaining out of the market. With regard to the future, should any fresh demand arise, values would undoubtedly respond, but, in the meantime, the present stagnant conditions are likely to prevail.

Prices have been :—

Soft Foreign Prompt.—Thursday, £23 15s.; Friday, £23 13s. 9d.; Monday, £23 12s. 6d.; Tuesday, £23 12s. 6d.; Wednesday, £23 10s.

Students' Corner

Q.—What is meant by venting a mould or core?

A.—Venting is to make channels in a mould or core by means of a vent wire for the escape of air and gas.

Q.—Why is it necessary to use the vent wire with moulds and cores?

A.—Because of expanded air and generated gases formed during pouring, and these must escape quickly in order to prevent blowing and scabbing.

Q.—To what extent does air expand when pouring a closed mould with cast iron?

A.—At an average pouring temperature the air would expand five times its volume.

Q.—With green-sand moulds or cores the sand is moistened with water (tempered). What is the increase in volume from water to steam?

A.—1,728 times, *id est*, a cub. in. expands to a cub. ft., or a 1-in. dia. ball becomes a 12-in. dia. ball.

Q.—What other gases are generated in a mould or core when being poured with molten iron?

A.—When the molten metal comes into contact with the sand mould and core, gases are generated from some of the ingredients in the composition of the facing sand, and core sand, such as coal-dust, manure, sawdust, oil, gums, and other vegetable matter.

Q.—But why stress the expansion of air, and generation of gases when pouring moulds?

A.—Because disastrous "blow-ups" and explosions have occurred from wet moulds and cores, also many thousands of waster castings have been made due to insufficient porosity in the sand, dampness, hard-ramming, inadequate use of the vent wire, neglect in bringing the air away into the atmosphere, and possibly some oversight preventing the rapid escape of air and gases.

Q.—Which requires the more liberal venting—hard-rammed mould or core, or a medium-rammed mould or core?

A.—Hard-rammed moulds and cores require the most venting, due to the sand being made dense from hard ramming, therefore less porous.

Q.—If strong milled sand, without the addition of opening material is used to form a mould, and a weak unmilled sand is used to form a similar mould, which mould would require the more venting?

A.—The strong milled sand, due to the high clay-content and milling making the sand dense and less porous.

Q.—Why is artificial opening material used when milling sand in a roller mill?

A.—To increase the permeability of the mixture, which has been reduced by the milling action.

Q.—What is understood by artificial opening-material?

A.—A "medium," such as horse manure, chopped straw, peat, moss-fibre, sawdust, etc., the addition of which increases the porosity and permeability of the sand.

XUM

Sterling

SOLID RIBBED ROLLED STEEL

MOULDING BOXES

are recognised as standard box equipment by the leading foundries and engineering establishments in this country and overseas.

Because they speed up production, save unnecessary labour, produce accurate castings and make for all-round efficiency in the foundry.

SEE **THE STERLING STAND** AT THE
FOUNDRY EXHIBITION,
Agricultural Hall, Islington, London, N.
JUNE 5th to 15th.
STAND No. 6, ROW C.

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FOUNDRY BARROWS

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SAND, COKE, and PIG-IRON
are sturdily built to withstand the heavy duties and harsh treatment of the severest foundry service.

STERLING FOUNDRY SPECIALTIES LTD.

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Code : WESTERN UNION.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
tandard cash	74	12	6
Three months	74	0	0
Electrolytic	84	5	0
Tough	78	0	0
Best selected	78	10	0
Sheets	110	0	0
India	93	0	0
Wire bars	84	12	6
Do. June	84	12	6
Do. July	84	12	6
Ingot bars	84	12	6
H.C. wire rods	86	17	6
Off. av. cash, May	75	2	6
Do. 3 mths., May	73	9	6 5/11
Do., Sttlmnt., May	75	2	4 7/11
Do., Electro, May	84	2	5 2/22
Do., B.S., May	76	19	8 5/22
Aver. spot price, copper, May	75	2	6
Do. wire bars, May	84	10	4 1/11
Solid drawn tubes			15½d.
Brazed tubes			15½d.
Wire			12½d.

BRASS.

Solid drawn tubes	13d.
Brazed tubes	15d.
Rods, drawn	12½d.
Rods, extd. or rlld.	8½d.
Sheets to 10 w.g.	11½d.
Wire	11½d.
Rolled metal	10½d.
Yellow metal rods	8½d.
Do. 4 × 4 Squares	9d.
Do. 4 × 3 Sheets	9½d.

TIN.

	£	s.	d.
Standard cash	200	12	6
Three months	203	15	0
English	202	0	0
Bars	205	15	0
Straits	204	15	0
Australian	204	5	0
Eastern	209	0	0
Banca	206	15	0
Off. av. cash, May	197	12	8 9/11
Do., 3 mths., May	200	2	11 5/11
Do., Sttlmt., May	197	12	11 5/11
Aver. spot, May	197	12	8 9/11

SPELTER.

	£	s.	d.
Ordinary	26	3	9
Remelted	24	10	0
Hard	21	10	0
Electro 99.9	29	5	0
English	26	12	6
India	23	0	0
Zinc dust	(Nom.) 36	10	0
Zinc ashes	9	0	0
Off. aver., May	26	13	4 11/11
Aver., spot, May	26	14	6 6/11

LEAD.

	£	s.	d.
Soft foreign ppt.	23	10	0
English	25	0	0
Off. average, May	23	16	11 15/22
Average spot, May	23	18	11 8/11

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	35	0	0
Do. V.M. ex whf.	33	7	6
Rods	42	0	0
Boiler plates	31	0	0
Battery plates	32	0	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	50	5	0
Chinese	34	0	0
Crude	Nominal		

QUICKSILVER.

	£	s.	d.
Quicksilver	22	3	9

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
25%	7	15	0
45/50%	12	0	0
75%	19	10	0
Ferro-vanadium—			
35/50%	..13/- lb. Va.		
Ferro-molybdenum—			
70/75% c. free	3/10 lb. Mo.		
Ferro-titanium—			
23/25% carbonless	11d. lb.		
Ferro-phosphorus, 20/25%	£16	0	0
Ferro-tungsten—			
80/85%, c. fr.	2/9 lb.		
Tungsten metal powder—			
98/99%	2/11 lb.		
Ferro-chrome—			
2/4% car.	£32	10	0
4/6% car.	£23	15	0
6/8% car.	£23	2	6
8/10% car.	£22	17	6
Ferro-chrome—			
Max. 2% car.	£34	0	0
Max. 1% car.	£37	12	6
Max. 0·70% car.	£41	12	6
70%, carbonless	1/2 lb.		
Nickel—99% cubes, or pellets	£175	0	0
Ferro-cobalt	9/4 lb.		
Aluminium 98/99%	£95	0	0
Metallic chromium—			
96/98%	2/6 lb.		
Ferro-manganese (net)—			
76/80% loose	£13	15	0
76/80% packed	£14	15	0
76/80%, export	£14	10	0
Metallic manganese—			
94/96%, carbonless	1/6 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0	2	0
Finshed bars, 18% tungsten	£0	2	9

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 5/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ¼ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy steel				3	18	0
Bundled steel and shrngs.	3	13	6 to	3	17	0
Mixed iron and steel	3	10	0 to	3	12	6
Heavy cast iron				3	5	0
Good machinery for foundries				3	10	0
Cleveland—						
Heavy steel				3	5	0
Steel turnings				2	18	6
Cast iron borings				2	15	0
Heavy forge				3	15	0
W.I. piling scrap				3	10	0
Cast-iron scrap	3	5	0 to	3	7	6
Lancashire—						
Cast-iron scrap	3	2	6 to	3	10	0
Hvy. wrought				3	15	0
Steel turnings				2	17	6
Scotland—						
Heavy steel				3	15	0
Cast-iron borings				2	14	6
Wrought-iron piling				3	12	6
Heavy machinery				3	12	0

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	60	0	0
Brass	39	0	0
Lead (less usual draft)	20	10	0
Tea lead	17	0	0
Zinc	17	0	0
New aluminium cuttings	67	0	0
Braziery copper	51	0	0
Gunmetal	51	0	0
Hollow pewter	140	0	0
Shaped black pewter	105	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	75/-
Foundry No. 3	72/6
Foundry No. 4	71/6
Forge No. 4	71/-
Hematite No. 1	74/6
Hematite M/Nos.	74/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	83/6
„ d/d Birm.	91/-
Midlands—	
Staffs. common*	—
„ No. 4 forge*	70/6
„ No. 3 fdry*	74/6
Shrops. basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	66/-
„ fdry. No. 3*	70/-
Derbyshire forge*	69/6
„ fdry. No. 3*	73/6
„ basic*	—
* d/d Black Country dist.	
Scotland—	
Foundry No. 1	77/-
„ No. 3	74/6
Hem. M/Nos.	78/-
Sheffield (d/d district)—	
Derby forge	64/6
„ fdry. No. 3	68/6
Lincs. forge	—
„ fdry. No. 3	72/6
E.C. hematite	86/-
W.C. hematite	87/-
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
„ fdry. No. 3	72/-
Northants foundry No. 3	—
Dalzell, No 3 (special)	102/6 to 105/-
Summerlee, No. 3	91/-
Glengarnock, No. 3	—
Gartsherrie, No. 3	91/-
Monkland, No. 3	91/-
Shotts, No. 3	91/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.) nom.				10	15	0
Nut and bolt iron	9	0	0 to	9	2	6
Hoops	11	0	0 to	11	10	0
Marked bars (Staffs.) f.o.t.				12	0	0
Gas strip	11	0	0 to	11	10	0
Bolts and nuts, ¾ in. × 4 in.				15	5	0
Steel—						
Ship plates	8	12	6 to	8	17	6
Boiler plts.				10	10	0
Chequer plts.				10	12	6
Angles				8	2	6
Tees				9	2	6
Joists				8	2	6
Rounds and squares, 3 in. to 5½ in.				9	2	6
Rounds under 3 in. to ¼ in. (Untested)				8	0	0
			and	upwards		
Flats, over 5 in. wide and up				8	7	6
Flats, 5 in. to 1½ in.				7	17	6
Rails, heavy				8	10	0
Fishplates				12	10	0
Hoops (Staffs.)				10	10	0
Black sheets, 24g.				10	10	0
Galv.cor.shts., 24g.	13	2	6 to	13	15	0
Galv. fencing wire 8g. plain				12	0	0
Billets, soft	6	10	0 to	7	0	0
Billets, hard	7	10	0 to	8	2	6
Sheet bars	6	5	0 to	6	10	0
Tin bars	6	5	0 to	6	10	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/4
Sheet to 10 w.g.	1/5
Wire	1/6½
Rods	1/5
Tubes	1/9
Castings	1/4

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4½ to 1/10½
To 15 in. wide	1/4½ to 1/10½
To 18 in. wide	1/5 to 1/11
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6 to 2/-
Ingots for spoons and forks	10d. to 1/6½
Ingots rolled to spoon size	1/1 to 1/9½
Wire round—	
3/0 to 10 G.	1/7½ to 2/2½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	21.76
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	15.00
Basic	20.26
Bessemer	20.76
Malleable	20.76
Grey forge	19.76
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bess billets	34.00
O.-h. billets	34.00
O.-h. sheet bars	36.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.95
Tank plates	1.95
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.20
Sheets, black, No. 24	2.85
Sheets, galv., No. 24	3.60
Sheets, blue an'l'd, No. 13	2.35
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv.	3.30
Tinplates, 100 lb. box	$5.35

COKE (at ovens).

Welsh foundry	25/- to 30/-
„ furnace	21/- to 23/-
Durham and North.	
„ foundry	16/6 to 17/6
„ furnace	17/6
Midlands, foundry	—
„ furnace	19/- and up

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14 box		18/3
„	28×20 „		36/6
„	20×10 „		26/3
„	18¾×14 „		18/9
C.W.	20×14 „		15/3
„	28×20 „		33/6
„	20×10 „		21/3
„	18¾×14 „		16/-
Terneplates	28×20		33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0 to	£7	10	0
Bars, hammered, basis	£17	10	0 to	£18	10	0
Bars and nail-rods, rolled, basis	£15	15	0 to	£16	15	0
Blooms	£10	0	0 to	£12	0	0
Keg steel	£32	0	0 to	£33	0	0
Faggot steel	£20	0	0 to	£24	0	0
Bars and rods, dead soft, steel	£10	0	0 to	£14	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½%	50%
Water	63¾%	45%
Steam	60%	40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£ s. d.		
June	6 ..	74 6 3	inc.	7/6
„	7 ..	75 0 0	„	13/9
„	10 ..	75 15 0	„	15/-
„	11 ..	76 7 6	„	12/6
„	12 ..	74 12 6	dec.	35/-

Electrolytic Copper.

		£ s. d.			
June	6 ..	84 5 0	No	change	
„	7 ..	84 5 0	„	„	
„	10 ..	84 5 0	„	„	
„	11 ..	84 5 0	„	„	
„	12 ..	84 5 0	„	„	

Standard Tin (cash).

		£ s. d.		
June	6 ..	198 0 0	inc.	10/-
„	7 ..	199 15 0	„	35/-
„	10 ..	200 7 6	„	12/6
„	11 ..	202 5 0	„	37/6
„	12 ..	200 12 6	dec.	32/6

Tin (English ingots).

		£ s. d.		
June	6 ..	199 10 0	inc.	10/-
„	7 ..	201 0 0	„	30/-
„	10 ..	202 0 0	„	20/-
„	11 ..	203 15 0	„	35/-
„	12 ..	202 0 0	dec.	35/-

Zinc Sheets (English).

		£ s. d.				
June	6 ..	35 0 0	No	change		
„	7 ..	35 0 0	„	„		
„	10 ..	35 0 0	„	„		
„	11 ..	35 0 0	„	„		
„	12 ..	35 0 0	„	„		

Spelter (ordinary).

		£ s. d.		
June	6 ..	26 5 0	dec.	3/9
„	7 ..	26 8 9	inc.	3/9
„	10 ..	26 7 6	dec.	1/3
„	11 ..	26 6 3	„	1/3
„	12 ..	26 3 9	„	2/6

Lead (English).

		£ s. d.				
June	6 ..	25 0 0	No	change		
„	7 ..	25 0 0	„	„		
„	10 ..	25 0 0	„	„		
„	11 ..	25 0 0	„	„		
„	12 ..	25 0 0	„	„		

AVERAGE PRICES OF GALVANISED CORRUGATED SHEETS (NORTH OF ENGLAND).

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1901	13 0 0	12 5 0	11 10 0	11 16 0	11 10 0	11 10 0	11 10 0	11 10 0	12 0 0	12 0 0	12 0 0	12 0 0	11 17 1
1902	12 0 0	11 10 0	11 10 0	11 10 0	11 15 0	11 15 0	11 15 0	11 15 0	11 15 0	11 15 0	11 15 0	11 15 0	11 14 2
1903	11 5 0	11 5 0	11 5 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 5 0	11 5 0	11 5 0	11 5 0	11 7 1
1904	11 5 0	11 5 0	11 5 0	11 5 0	10 15 0	10 15 0	10 15 0	10 15 0	10 5 0	10 5 0	10 5 0	10 5 0	10 15 0
1905	10 7 6	10 7 6	10 7 6	10 7 6	10 7 6	10 7 6	10 7 6	11 0 0	11 5 0	11 5 0	11 15 0	12 0 0	10 15 0
1906	12 12 6	12 12 6	12 12 6	12 7 6	12 7 6	12 7 6	12 12 6	12 12 6	12 15 0	12 15 0	12 15 0	13 5 0	12 12 11½
1907	13 5 0	13 5 0	13 15 0	13 15 0	13 15 0	13 15 0	13 17 6	13 17 6	13 17 6	13 2 6	13 2 6	13 2 6	13 10 10
1908	13 2 6	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 11 0½
1909	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	10 10 0	11 0 0	11 0 0	11 0 0	11 0 0	11 16 8
1910	11 15 0	12 5 0	12 5 0	11 15 0	11 10 0	11 10 0	11 12 6	11 12 6	11 12 6	11 12 6	11 10 0	11 10 0	11 13 4
1911	11 5 0	11 1 3	10 15 0	10 15 0	10 13 9	10 10 0	10 13 9	11 0 0	11 5 0	11 5 0	11 5 0	11 7 0	10 19 7½
1912	11 10 0	11 10 0	11 10 0	11 15 0	12 5 0	12 5 0	12 5 0	12 5 0	12 5 0	12 12 6	12 18 0	12 15 0	12 2 11½
1913	12 15 0	12 15 0	12 15 0	12 11 3	11 18 0	11 15 0	11 15 0	11 15 0	11 15 0	11 3 0	11 0 0	11 2 6	11 18 4
1914	11 7 0	11 7 6	11 7 6	11 5 7½	11 2 6	10 15 0	10 15 0	12 17 6	14 2 0	13 7 0	11 15 7	11 2 6	11 16 0
1915	11 10 8½	13 12 6	14 8 9	15 0 6	17 17 6	20 17 6	20 17 6	20 6 3	17 12 6	18 1 0	22 13 9	25 2 0	18 3 4½
1916	26 5 0	27 12 6	28 0 0	28 5 0	29 0 0	29 0 0	28 15 0	28 3 0	28 15 0	28 15 0	28 15 0	28 15 0	28 6 8½
1917	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 0 0	28 0 0	28 0 0	28 11 3
1918	28 5 0	28 15 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	28 13 4
1919	29 0 0	29 0 0	29 0 0	28 10 0	28 10 0	27 7 6	27 5 0	29 3 0	32 0 0	33 0 0	36 10 0	40 8 4	31 5 3½
1920	46 10 0	49 15 0	53 15 0	56 0 0	55 10 0	54 10 0	52 10 0	48 10 0	44 3 4	39 2 6	35 17 6	30 8 0	47 4 3
1921	28 10 0	25 17 6	24 5 0	23 3 4	22 0 0	22 0 0	23 10 0	21 12 6	20 0 0	18 15 0	18 3 9	17 2 0	22 1 7
1922	16 17 6	15 13 9	16 3 0	16 10 0	16 4 4½	15 15 6	15 16 3	16 16 0	16 8 9	16 6 3	17 1 0	17 7 6	16 7 5½
1923	18 3 1½	19 1 11½	19 8 0	19 10 0	19 7 0	19 1 3	18 0 0	18 13 1½	19 0 0	19 3 9	19 2 6	18 19 4½	18 19 2
1924	18 13 6	18 9 4½	18 5 0	17 15 11½	17 3 0	17 19 4½	18 7 6	18 8 1½	18 8 1½	17 19 6	17 11 3	17 10 0	18 0 10½
1925	17 8 6	17 1 6½	16 9 4½	16 12 0	16 9 8½	16 9 4½	16 0 6	16 1 10½	16 5 0	16 12 6	6 15 0	16 11 0½	
1926	16 14 4½	16 5 7½	16 0 6	15 11 10½	15 11 3	16 0 0	16 16 0	16 18 9	16 14 0	16 18 9	17 10 0	6 19 0	16 10 0½
1927	16 3 1	15 7 6	15 3 3	15 3 1½	14 14 4½	14 11 6	14 1 10½	14 0 0	13 19 6	13 16 10½	13 13 1½	13 3 9	14 9 10¼
1928	13 0 0½	13 2 6	13 6 0	13 2 6	13 3 0	13 6 9	13 11 3	13 10 0	13 10 7½	13 12 6	13 11 6	13 10 0	13 8 8½
1929	13 11 0	13 13 1½	13 12 9½	13 10 11½	13 9 3	—	—	—	—	—	—	—	—

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